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CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA. W--ETC(U)

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WASTEWATER MANAGEMENT STUDY

APPENDIX V
LAND TREATMENT

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AUGUST 1973

FOR

CLEVELAND – AKRON METROPOLITAN

AND

THREE RIVERS WATERSHED AREAS

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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This land treatment technical appendix to the Survey Scope Study provides the basic soil, geological and hydrological data for this study as a starting point for planners and engineers who may be involved in future land treatment works in northern Ohio. This appendix does not deal with the actual planning and preliminary engineering of the land treatment components of the study. It is primarily oriented toward defining the physical constraints and opportunities related to land treatment in the Lake Erie Basin or northern Ohio. The appendix discusses the conventional criteria for selecting soils cont

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for land treatment and the rationale for a new set of criteria developed during this Survey Scope Study. The reader will learn that the soils selected for the Cleveland-Akron/Three Rivers Basin are generally far more fine grained and impermeable than previously thought to be "optimum." These tighter soils have been selelcted, and the 46,000 acres of sandy soils, which were originally at the top of the list, have been bypassed.

This appendix is intended to provide the basis for determining physical feasibility of land treatment for the Three Rivers Basin. The report does not attempt to provide final design data, but assumes that detailed studies will proceed on specific sites after the selection of general areas.

(6) CLEVELAND-AKRON METROPOLITAN
AND THREE RIVERS WATERSHED AREA.
WASTEWATER MANAGEMENT SURVEY SCOPE STUDY.

Appendix V.
LAND TREATMENT. ~~TECHNICAL APPENDIX~~

PHASE I REPORT.

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DENVER, COLORADO

DECEMBER 20, 1972

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SECTION I

INTRODUCTION

This land treatment technical appendix to the Survey Scope Study provides the basic soil, geological, and hydrological data for this study as a starting point for planners and engineers who may be involved in future land treatment works in northern Ohio. The total volume of pertinent data available for northern Ohio is immense. A small library could be created from the publications concerning the geographic and physical characteristics of this region.

The abundance of data available to planners and engineers is a tribute to the diligence of the State of Ohio agencies, federal agencies, and others who have worked over the years to accumulate the various basic data inventories.

This appendix does not deal with the actual planning and preliminary engineering of the land treatment components of the study. It is primarily oriented toward defining the physical constraints and opportunities related to land treatment in the Lake Erie Basin of northern Ohio.

The appendix discusses the conventional criteria for selecting soils for land treatment and the rationale for a new set of criteria developed during this Survey Scope Study. The reader will learn that the soils selected for the Cleveland-Akron/Three Rivers Basin are generally far more fine grained and impermeable than previously thought to be "optimum." These tighter soils have been selected, and the 46,000 acres of sandy soils, which were originally at the top of the list, have been bypassed.

The scope of work for this Appendix of Land Treatment Technical Data is summarized as follows:

1. Inventory and identify potential land treatment areas in the Ohio portion of the Lake Erie drainage basin.

2. Classify the land treatment soils as to land treatment characteristics.

3. Present basic data in a useful form for reference purposes.

4. Provide a report on the findings with appropriate rationale given for the selection of soils and application rates. Present additional data and findings related to land treatment.

This Appendix is intended to provide the basis for determining physical feasibility of land treatment for the Three Rivers Basin. The report does not attempt to provide final design data, but assumes that detailed studies will proceed on specific sites after the selection of general areas.

SECTION II

INVENTORY OF SOILS FOR LAND TREATMENT AREAS

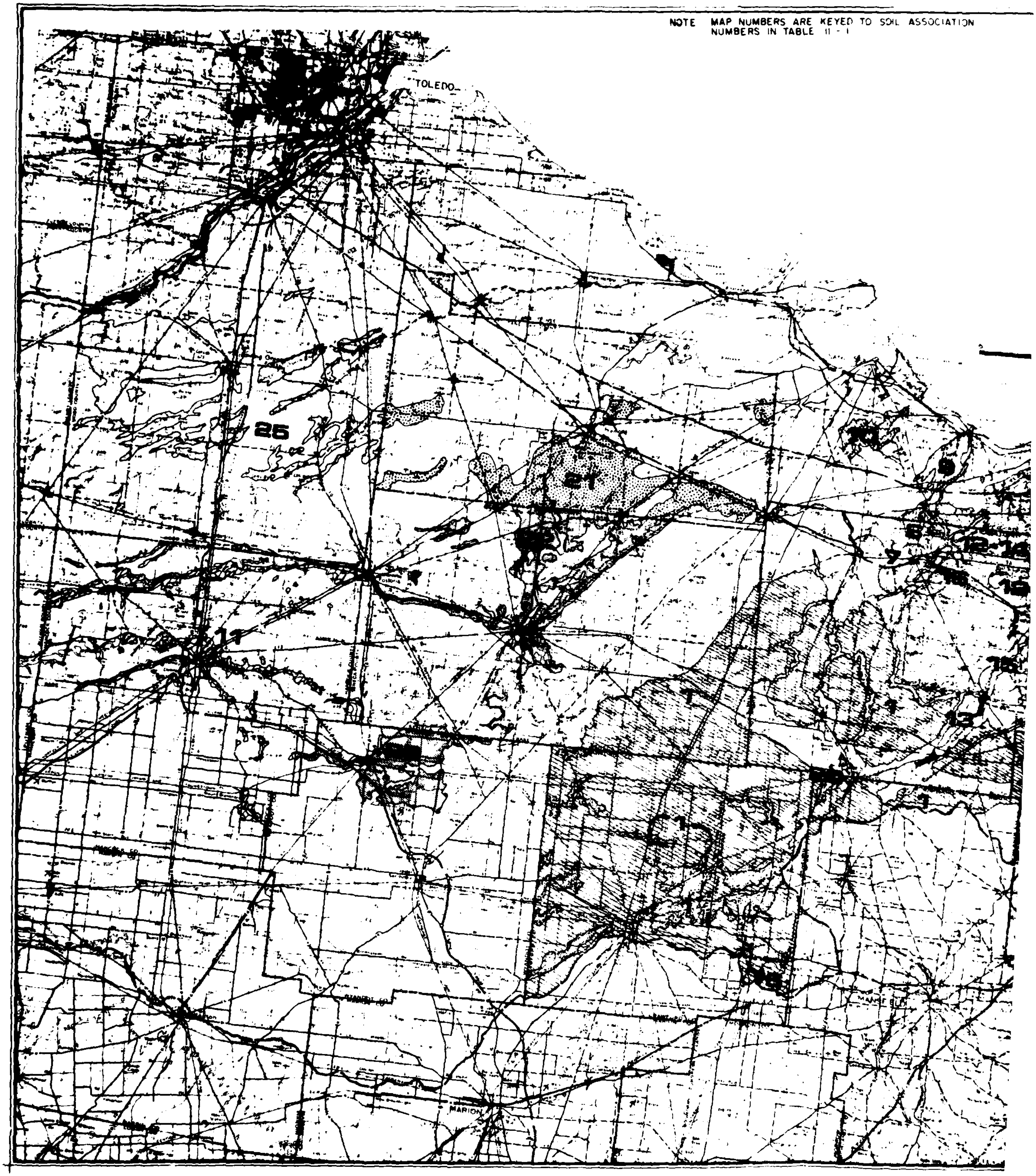
The searching out and identification of potentially suitable lands was limited to the Lake Erie Basin of northern Ohio as far west as Hancock County, and easterly to the Pennsylvania border. The 21 counties included in the review are listed below and shown on Figure II-2.

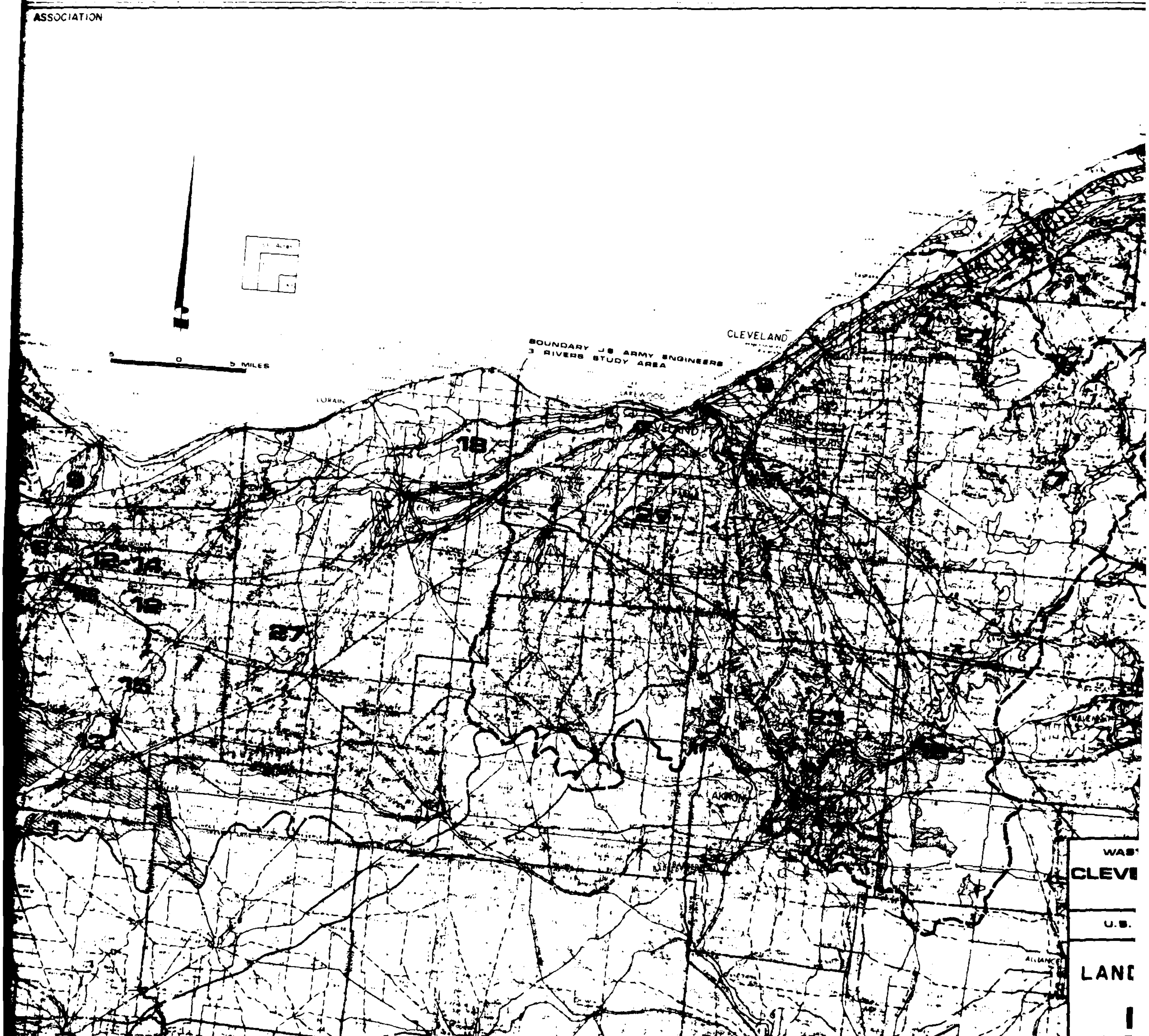
1. Ashland
2. Ashtabula
3. Crawford
4. Cuyahoga
5. Erie
6. Geauga
7. Hancock
8. Hardin
9. Huron
10. Lake
11. Lorain
12. Medina
13. Ottawa
14. Portage
15. Richland
16. Sandusky
17. Seneca
18. Summit
19. Trumbull
20. Wood
21. Wyandot

Soil classification data from published and unpublished sources, field interviews with soil and agricultural specialists in Ohio, field and office investigations by special agricultural consultants from Colorado State University, and special basic data gathered by the Columbus office of the Soil Conservation Service provided the foundation for this inventory of potential land treatment areas.

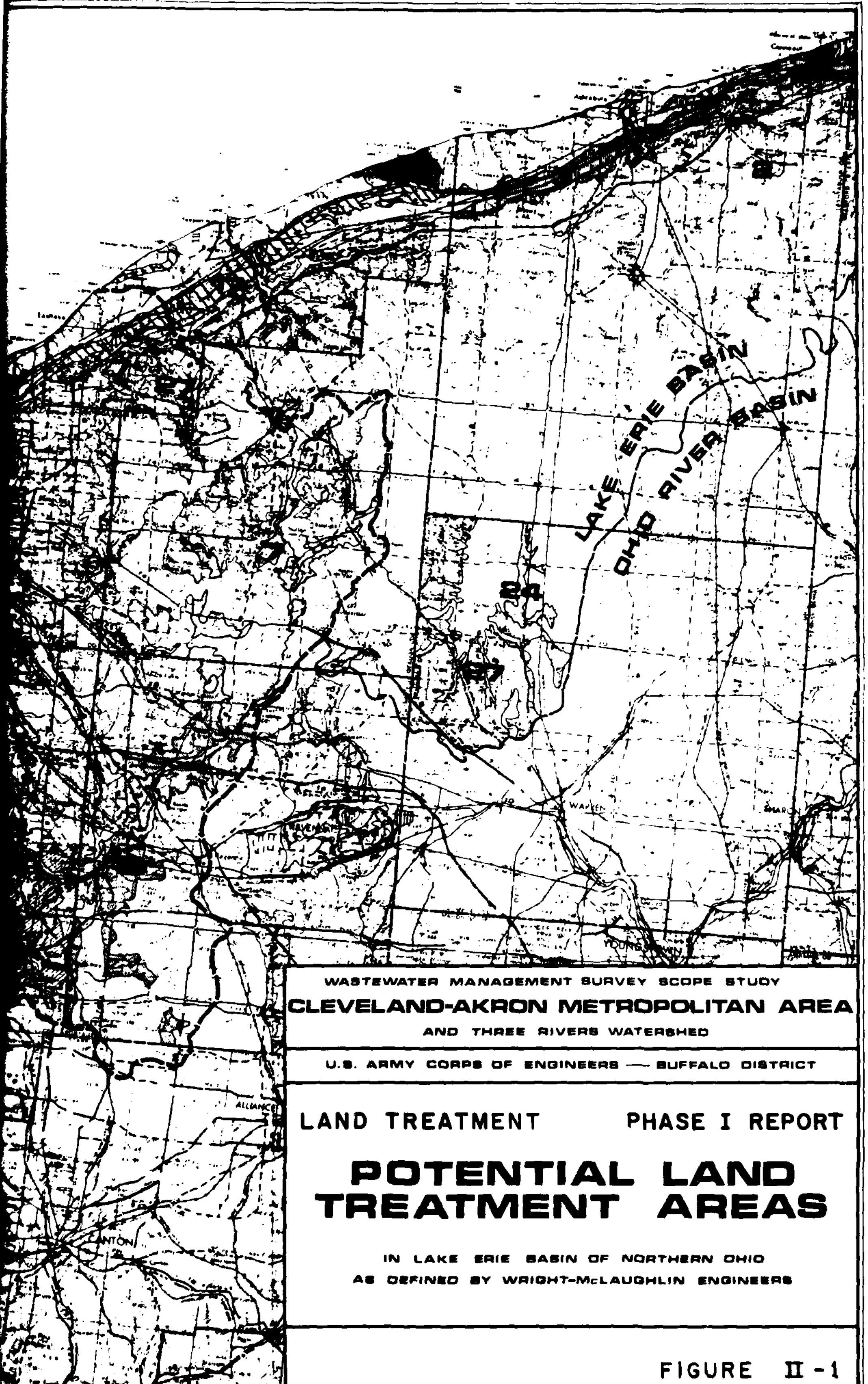
The analysis and inventory of these data resulted in the compilation of Table II-1. An explanation of column headings is presented in Table II-2. Each of the soil associations listed in Table II-1 is shown on Figure II-1, a map of the Lake Erie Basin of northern Ohio.

The reader is referred to Section III of this appendix for information on data sources and references.


NOTE MAP NUMBERS ARE KEYED TO SOIL ASSOCIATION NUMBERS IN TABLE II - I
TOLEDO
25
9
12-14
16
13
MARION


ASSOCIATION
CLEVELAND
BOUNDARY US ARMY ENGINEERS
3 RIVERS STUDY AREA
5 0 5 MILES
LORAIN
AKRON
MASSILLON
ALLIANCE
CLEVE
U.S.
LAND

. 2



WASTEWATER MANAGEMENT SURVEY SCOPE STUDY

CLEVELAND-AKRON METROPOLITAN AREA

AND THREE RIVERS WATERSHED

U.S. ARMY CORPS OF ENGINEERS — BUFFALO DISTRICT

LAND TREATMENT PHASE I REPORT

POTENTIAL LAND TREATMENT AREAS

IN LAKE ERIE BASIN OF NORTHERN OHIO
AS DEFINED BY WRIGHT-McLAUGHLIN ENGINEERS

FIGURE II-1

CLASSIFICATION OF SOIL ASSOCIATIONS SELECTED AS POTENTIAL LAND TREATMENT AREAS

TABLE B-1 Sheet 1 of 8

ASHLAND		Cardington-		A	0-8	sil	5.1-6.0	2.1		0-6		0.63-2.0	0.18-0.23	2.5	Clay till Loam	5+	1½-3	24.3	57.0	18.7	ML-CL,ML	A-4,A-6	95-100	85-100	70-95	Low	---	High	No Limiting Factors	Agri-culture	Crops, Pasture, & 15% Wooded	Excellent	Good
				B	8-18	silcl	5.1-6.0	0.7				0.2-0.63	0.19-0.21					19.1	48.6	32.3	CL	A-6	95-100	85-100	70-85	Moderate	Low	High					
				B	18-30	silcl	5.6-7.3					0.2-0.63	0.18-0.19					23.4	48.9	27.7	CL	A-6	95-100	85-100	70-85	Moderate	Low	High					
				C	30-60	cl	7.4-8.0					0.2-0.63	0.16-0.18					24.2	51.6	24.2	CL,ML-CL	A-6	90-100	80-95	60-80	Moderate	Low	High					
	1		9,800																														
		Bennington		A	0-6	sil or l	5.0-6.0	2.6	15.2	0-6		0.63-2.0	0.16-0.20	2.5	Clay till Loam	5+	½-1½	20.3	62.2	17.5	ML-CL,ML	A-4,A-6	95-100	85-100	70-95	Low	---	Moderate			Crops, Pasture, & 15% Wooded	Excellent	Good
				A	6-12	scl	5.0-6.0	0.9	15.9			0.2-0.63	0.15-0.18					20.7	53.9	25.4	CL	A-6	95-100	85-100	70-85	Moderate	Moderate	Moderate					
				B	12-32	cl	5.1-7.3	0.8	22.5			0.2-0.63	0.15-0.18					27.4	41.1	31.5	CL	A-6	95-100	85-100	70-85	Moderate	Moderate	Moderate					
				C	32-60	silcl	7.4-8.0					0.2-0.63	0.15-0.18					19.8	49.9	30.3	CL,ML,ML	A-6	90-100	80-95	60-80	Moderate	Low	Low					
	27	Mahoning-Ellsworth	5,600	SAME AS FOR MEDINA COUNTY																									Flat	50% Rural	15% Wooded	Excellent	Good
ASHTABULA		Chenango-			0-7	sil	4.5-6.5	2.6		0-18	0.2-5.0	2.0-6.3	0.17-0.20	3.5	Sand & Gravel	5+	3+	55.6	33.4	11.0	ML	A-4	100	90-100	70-90	Low	---	High	No Limiting Factors	60% Agri-culture	30% Wooded	Good	Good
					7-23	l	5.6-6.0	0.3				6.3-12.0	0.12-0.15					75.0	15.6	9.4	SM	A-2,A-4	70-95	55-65	15-45	Low	Low	High					
					23-41	sl	5.1-5.5	0.3				6.3-12.0	0.04-0.07					84.4	8.2	7.4	[illegible]	A-1,A-2	40-70	30-50	1-15	Low	Low	High					
	2		1,600																														
		Red Hook			0-7	sil	6.1-6.5				0.2-5.0	5.0-15.0		4.0	Sand & Gravel	5+	4	61.3	27.0	11.7									No Limiting Factors	40% Urban		Good	Good
					7-46	l or sl	4.5-5.0					0.5-15.0						64.4	25.7	9.9													
					46+	gs						5.0-15.0						93.2	1.5	5.3													
		Colonie-			0-10	fs	4.5-5.0				>5.0	6.3-12.0	0.06-0.10	2.5	Fine Sand	5+	4	91.3	6.6	2.1	SM	A-2,A-4	100	100	15-40	Low	Low	High	No Limiting Factors	Primarily Occupied By Roads	40% Wooded	Fair	Accept-able
					10-15	fs	4.5-5.0					6.3-12.0	0.06-0.10					85.3	9.3	5.4	SM,SP-SM	A-2,A-3	100	95-100	5-35	Low	Low	High to Mod.					
					25+	ls	6.1-6.5					6.3-12.0	0.04-0.08					95.8	3.3	0.9	SM,SP-SM	A-2,A-3	100	95-100	5-35	Low	Low	High to Mod.					
	3		21,500																														
		Elnora			0-10	fsl	4.5-6.5				2.0->5.0	6.3-12.0+	0.06-0.10	4.5	Fine Sand	5+	1½-3				SM	A-2,A-4	95-100	95-100	20-40	Low	Low	High	No Limiting Factors	[illegible] & Urbanization		Fair	Accept-able
					10-33	fsl or fs	4.5-5.0					6.3-12.0+	0.06-0.10								SM	A-2,A-4	95-100	95-100	20-40	Low	Low	High					
					33-52	lfs or fs	4.5-5.0					6.3-12.0+	0.04-0.08								SM	A-2,A-4	100	100	15-40	Low	Low	High					
					52+	lfs or fs	5.1-5.5					6.3-12.0+									SM	A-2,A-4	100	100	15-40	Low	Low	High					
		Otisville-			0-6	gl	6.1-6.5				>5.0	6.3-12.0	0.08-0.12	1.5	Sand & Gravel	5+	4+				SM	A-2	75-100	60-85	20-35	Low	---	High	No Limiting Factors	50% Urbanization	50% Wooded	Fair	Accept-able
					6-18	gl	4.5-5.0					6.3-12.0	0.03-0.06								SM, SP-SM		80-100	30-50	5-20	Low	Low	High					
					18+	s & g	5.1-5.5					6.3-12.0	0.02-0.06								GM, GW, SM, SM	A-2,A-1	50-100	10-100	5-20	Low	Low	High					
	4		12,400																														
		Chenango		SAME AS ABOVE																												Good	Good
CRAWFORD		Cardington-		A	0-8	sil	5.1-6.0	2.1		0-6		0.63-2.0	0.18-0.23	2.5	Clay till Loam	5+	1½-3	24.3	57.0	18.7	ML-CL,ML	A-4,A-6	95-100	85-100	70-95	Low	---	High	No Limiting Factors	Agri-culture	Crops, Pasture, & 15% Wooded	Excellent	Good
				B	8-18	silcl	5.1-6.0	0.7				0.2-0.63	0.19-0.21					19.1	48.6	32.3	CL	A-6	95-100	85-100	70-85	Moderate	Low	High					
				B	18-30	silcl	5.6-7.3					0.2-0.63	0.18-0.19					23.4	48.9	27.7	CL	A-6	95-100	85-100	70-85	Moderate	Low	High					
				C	30-60	cl	7.4-8.0					0.2-0.63	0.16-0.18					24.2	51.6	24.2	CL,ML-CL	A-6	90-100	80-95	60-80	Moderate	Low	High					
		Lobdell-		A	0-9	sil	5.6-6.0					0.63-2.0	0.18-0.24	>1	Silt, Loam Alluvium	5+	1½-3				ML, CL	A-4,A-6	90-100	90-100	70-90	Low	---	Moderate	Some Flood Hazard	95% Rural	10% Wooded	Good	Good
	1		203,700	C	9-60	sil	5.6-6.9					0.63-2.0	0.15-0.18								ML, CL	A-4,A-6	90-100	90-100	70-90	Low	Moderate	High					
		Bennington		A	0-6	sil or l	5.0-6.0	2.6	15.2	0-6		0.63-2.0	0.16-0.20	2.5	Clay till Loam	5+	½-1½	20.3	62.2	17.5	ML-CL,ML	A-4,A-6	95-100	85-100	70-95	Low	---	Moderate			Crops, Pasture, & 15% Wooded	Excellent	Good
				A	6-12	scl	5.0-6.0	0.9	15.9			0.2-0.63	0.15-0.18					20.7	53.9	25.4	CL	A-6	95-100	85-100	70-85	Moderate	Moderate	Moderate					
				B	12-32	cl	5.1-7.3	0.8	22.5			0.2-0.63	0.15-0.18					27.4	41.1	31.5	CL	A-6	95-100	85-100	70-85	Moderate	Moderate	Moderate					
				C	32-60	silcl	7.4-8.0					0.2-0.63	0.15-0.18					19.8	49.9	30.3	CL,ML-CL	A-6	90-100	80-95	60-80	Moderate	Low	Low					
		Digby-		SAME AS FOR HANCOCK COUNTY																												Fair	Fair
	6	Haney-	----	SAME AS FOR RICHLAND COUNTY																												Good	Good
		Hillgrove		A	0-10	l	6.6-7.3			0-2		0.63-2.0	0.16-0.22	3.0	Gravelly Loam or Clay	5+													Some Closed Depressions			Good	Good
				B	10-20	l	6.6-7.3					0.63-2.0	0.16-0.22																				
				B	20-30	scl	6.6-7.3					0.63-2.0	0.14-0.18																				
				B	30-38	gscl	6.6-7.3					0.63-2.0	0.14-0.18																				
				C	38-60	gsl	6.6-7.3					0.63-2.0	0.14-0.18																				
CUYAHOGA	7	Chili	15,400	A	0-7	l	4.5-5.0	2.2	14.0	1-15		2.0-6.3	0.10-0.15	3.5	Gravel & Sand w/ Fines	5+	3+	23.6	60.5	15.4	ML	A-4	80-90	70-85	45-70	Low	---	High	Erosion on Steeper Slopes	50% Urban & Highways		Fair	Fair
				B	7-26	scl or l	5.1-5.5	0.4	12.0			2.0-6.3	0.08-0.15					21.8	58.0	20.2	GM, ML	A-2,A-4	55-85	50-60	25-55	Low	Low	High					
				C	26-60	s & g	5.1-5.5	0.1	8.9			>12.0	0.02-0.04					64.3	18.0	17.7	GM-GM, SP-SM, SM	A-1,A-2	30-75	30-50	5-25	Low	Low	High					
	8	Painesville	13,000		0-14	sil	5.0-6.5			1-3																				100% Urban		Fair	Fair
					14-40	scl or sl	5.5-6.5																										
					40-60	slc & sl																											
	27	Mahoning-Ellsworth-Trumbull	179,000	SAME AS FOR MEDINA COUNTY																									Few Limiting Factors	80% Urban	Heavily Wooded Non-urban	Excellent	Good

CLASSIFICATION OF SOIL ASSOCIATIONS SELECTED AS POTENTIAL LAND TREATMENT AREAS

(1) COUNTY	(2) SOIL ASSOCIATION MAP NO.	(2) NAME	(3) GROSS AREA (ACRES)	(4) DEPTH HORIZ.	(4) DEPTH INCHES	(5) TEXTURE DOMINANT USDA	(6) REACTION pH	(7) EXISTING ORGANIC MATTER (%)	(8) C.E.C. (MEQ./100 GM)	(9) SLOPE (%)	(10) HYDRAULIC CAPACITY INFILTRATION (IN/HR)	(11) HYDRAULIC CAPACITY PERMEABILITY (IN/HR)	(12) AVAILABLE MOISTURE (IN/IN of SOIL)	(13) SUBSTRATUM DEPTH (FT.)	(14) SUBSTRATUM MATERIAL	(15) ROCK DEPTH (FT.)	(16) PRESENT SEASONAL HIGH WATER TABLE (FT.)	(17) PARTICLE DISTRIBUTION % SAND	(18) % SILT	(19) % CLAY	(20) CLASSIFICATION UNIFIED	(21) CLASSIFICATION AASHO	(22) PERCENT PASSING SIEVE No 4 (4.7mm)	(23) No 10 (2.0mm)	(24) No 200 (0.074mm)	(25) SHRINK SWELL POTENTIAL	(26) CORROSIVITY UNCOATED STEEL	(27) CORROSIVITY CONCRETE	(28) TERRAIN CHARACTER	(29) LAND USE CURRENT	(30) VEGETAL COVER	(31) ORGANIC REMOVAL	(32) HEAVY METAL STORAGE CAPACITY
ERIE		Sisson-		A	0-10	sil, fsl or fsl	6.6-7.3	1.6	8.9	2-10		0.63-2.0	0.15-0.20	3.0	Lacustrine	5+	2½ - 4	61.6	28.8	9.6	ML, CL	A-4,A-6	100	100	70-90	Low	Low	Low	Erosion on	70%	15%	Fair	Fair
				B & C	10-40	sil	6.6-7.3	0.4	11.8			0.63-12.0	0.15-0.20		Silt &			39.8	36.2	24.0	ML, CL	A-4,A-6	100	100	70-90	Low	Low	Low	steep	Rural	Wooded		
				C	40-60	sil or fs	7.4-8.4						0.13-0.16		Fine Sand			51.2	40.1	8.4	ML	A-4	100	100	90-100	Low	Low	Low	areas				
	9		8,600																														
		Tuscola		A	0-10	fsl, vfsl, sil	5.6-6.5			0-6		0.63-12.0	0.06-0.23	3.5	Lacustrine	5+	2½ - 4	73.7	21.7	4.6	ML	A-4	100	100	40-55	Low	Low	Moderate				Good	Good
				B	10-32	scl	5.6-6.5					0.63-2.0	0.14-0.18		Silt			71.1	22.0	6.9	ML	A-4	100	100	40-55	Low	Low	Moderate					
				C	32-42	sil	6.1-7.3					0.63-2.0	0.18-0.23					30.1	40.7	29.5	SM-ML	A-4	100	100	40-55	Low	Low	Low					
				C	42-60	sil or fs	7.4-8.4					2.0-12.0	0.04-0.23					16.0	57.8	26.2	ML	A-4	100	100	50-95	Low	Low	Low					
		Arkport-		A	0-11	lfs	6.6-7.4	1.4	8.0	0-18		6.3-12.0	0.08-0.12	2.5	Loamy	5+	1½ - 3	85.7	8.8	5.5	SM	A-2	100	95-100	5-35	Low	Low	Moderate		60% Ur-		Fair	Accept-
				B & C	11-60	lfs	6.6-7.4	0.3	5.0			2.0-12.0+	0.06-0.08		Sand			91.1	5.4	3.5	SM	A-2,A-4	100	90-100	30-45	Low	Low	Moderate		banized			able
	10		11,200																														
		Galen		A	0-10	lfs or fsl	6.6-7.4			0-6		0.0-12.0	0.06-0.16	2.5	Fine	5+	2 - 3				SM	A-2	100	90-100	10-25	Low	Low	Moderate		Urban-	15%	Fair	Accept-
				A	10-20	lfs	6.6-7.4					6.3-12.0	0.06-0.08		Sand						SM	A-2	100	90-100	10-25	Low	Low	Moderate		ized	Wooded		able
				A & B	20-44	fs	6.6-7.4					6.3-12.0	0.04								SM	A-2,A-4	95-100	90-100	30-50	Low	Low	Low					
				A & B	44-60	fs						6.3-12.0	0.04								SM	A-2,A-4	95-100	90-100	30-50	Low	Low	Low					
	27	Mahoning-	29,000	SAME AS FOR MEDINA COUNTY																									Flat	90%	20%	Excellent	Good
		Bogart		SAME AS FOR HURON COUNTY																										Rural	Wooded	Fair	Acceptable
		Haskins		SAME AS FOR LORAIN COUNTY																												Excellent	Good
		Jimtown		SAME AS FOR LORAIN COUNTY																												Good	Good
GEAUGA	7	Chili	13,100	SAME AS FOR CUYAHOGA COUNTY																									Some Steep Terrain	60% Rural	25% Wooded	Fair	Fair
	27	Mahoning-Ellsworth	43,900	SAME AS FOR [illegible] COUNTY																									Few Limiting Factors	30% Urban	60% Wooded	Excellent	Good
HANCOCK		Belmore-		SAME AS FOR RICHLAND COUNTY																												Good	Fair
		Digby-		A	0-9	l or scl	5.6-6.0			0-2		0.63-2.0	0.14-0.18	2.5	Gravel &	5+	< 1½	55.8	29.6	14.6	ML	A-4	90-95	80-90	65-75	Low	---	Low				Good	Fair
				B	9-25	scl	6.6-7.4					0.63-6.3	0.10-0.18		Sand;Clay			55.1	29.0	15.9	CL,SC	A-6	85-95	80-90	35-55	Moderate	High	Low		60%			
				B & C	25-60	sl	7.4-8.4					2.0-6.3	0.14-0.18		poss.bel.42"						SM	A-2	70-85	50-65	15-25	Low	High	Low	Flat	Occupied			
	11		21,800	A	0-9	fsl	6.1-6.5			0-2	0.2→5.0	5.0->15.0		3.5	Lacustrine	5+		92.5	6.4	1.1									to	by	10%	Fair	Fair
		Seward-		A & B	9-37	ls or sl	5.6-6.5								Clay or			95.0	2.8	2.2									Slightly	Highways	Wooded		
				C	37+										Clay fill			23.9	47.4	28.7									Sloped	or			
																														Urbaniza-tion			
		Ottokee		A	0-9	lfs	6.1-6.5			0-5	> 15.0	6.3-12.0	0.05-0.09	5.0	Fine Sand	5+	1½ - 3	95.3	0.6	4.1	SM	A-2	100	100	15-30	Low	Low	Low				Fair	Accept-
				A	9-16	lfs	6.1-6.5					6.3-12.0	0.05-0.09								SM	A-2	100	100	15-30	Low	Low	Low					able
				A & B	16-60	lfs or s	7.4-7.8					6.3-12.0	0.05-0.09								SM	A-2	100	100	20-35	Low	Low	Low					
HARDIN		--0--																															
HURON		Bennington-		A	0-6	sil or l	5.0-6.0	2.6	15.2	0-6		0.63-2.0	0.16-0.20	2.5	Clay till	5+	½ - 1½	20.3	62.2	17.5	ML-CL,ML	A-4,A-6	95-100	85-100	70-95	Low	---	Moderate	No	85%	10%	Excellent	Good
				A	6-12	scl	5.0-6.0	0.9	15.9			0.2-0.63	0.15-0.18		Loam			20.7	53.9	25.4	CL	A-6	95-100	85-100	70-85	Moderate	Moderate	Moderate	Limita-	Rural	Wood		
				B	12-32	cl	5.1-7.3	0.8	22.5			0.2-0.63	0.15-0.18					27.4	41.1	31.5	CL	A-6	95-100	85-100	70-85	Moderate	Moderate	Moderate	tions				
				C	32-60	sicl	7.4-8.0					0.2-0.63	0.15-0.18					19.8	49.9	30.3	CL,ML-CL	A-6	90-100	80-95	60-80	Moderate	Low	Low					
	1		79,200																														
		Cardington		A	0-8	sil	5.1-6.0	2.1		0-6		0.63-2.0	0.18-0.23	2.5	Clay till	5+	1½ - 3	24.3	57.0	18.7	ML-CL,ML	A-4,A-6	95-100	85-100	70-95	Low	---	High	No	85%	10%	Excellent	Good
				B	8-18	sicl	5.1-6.0	0.7				0.2-0.63	0.19-0.21		Loam			19.1	48.6	32.3	CL	A-6	95-100	85-100	70-85	Moderate	Low	High	Limita-	Rural	Wood		
				B	18-30	sicl	5.6-7.3					0.2-0.63	0.18-0.19					23.4	48.9	27.7	CL	A-6	95-100	85-100	70-85	Moderate	Low	High	tions				
				C	30-60	cl	7.4-8.0					0.2-0.63	0.16-0.18					24.2	51.6	24.2	CL,ML-CL	A-6	90-100	80-95	60-80	Moderate	Low	High					
	12	Berrien	1,100	SAME AS FOR LAKE COUNTY																									No Limitations	85% Rural	10% Wood	Fair	Acceptable
	13	Bogart	1,300	A	0-7	sl	5.5-6.0			0-2		0.63-2.0	0.17-0.20		Gravel &	5+	3 - 4	45.7	42.9	11.4	ML, SM, GM	A-4	75-85	70-80	36-65	Low	Moderate	Moderate	No Limit-	85% Rural	10%	Fair	Accept-
				A & B	7-22	sl	5.5-6.0					0.63-2.0	0.16-0.18		Sand			49.8	36.4	13.8	SM or SC	A-2,A-4	75-85	70-80	36-65	Low	Moderate	Low	ations		Wooded		able
				B & C	22-28	gcl	5.5-6.0					0.63-2.0	0.12-0.15					62.9	21.0	16.1	SM or SC	A-2,A-4	80-85	66-75	30-50	Low	Moderate	Low					
				C	28-42	gsl	5.5-6.0					2.0-6.3	0.04-0.07					74.8	14.4	10.8	SM, SC	A-1,A-2,A-4	60-85	55-65	15-40	Low	Moderate	Low					
				C	42-60	g & s	5.5-6.5					6.3-12.0	< 0.05					76.6	8.9	14.5	SM, SC	A-1,A-2,A-4	60-85	55-65	15-40	Low	Moderate	Low					
	7	Chili	4,400	A & B	0-12	sil	4.5-5.5	1.4	12.9	0-8		2.0-6.3	0.10-0.14		Strati-	5+	3+	24.1	60.5	15.4	ML	A-4	80-90	70-85	45-70	Low	---	High	No Limit-	85%	10%	Fair	Fair
				B	12-26	gl	4.5-5.5	0.2	13.1			2.0-6.3	0.04-0.07		fied			21.8	58.0	6.0	GM,ML	A-2,A-4	55-85	50-60	25-55	Low	Low	High	ations	Rural	Wooded		
				C	26-60+	gsl,gls	5.6-6.5	0.1	4.8			> 6.3			Gravel			77.5	9.2	13.3	GM,GM,SM	A-1,A-4	20-75	20-50	5-25	Low	Low	High					
	14	Olena	5,500	SAME AS CHILI SOIL																									No Limitations	85% Rural	10% Wood	Fair	Fair
	8	Painesville	1,300	SAME AS FOR CUYAHOGA COUNTY																									No Limitations	85% Rural	10% Wood	Fair	Fair

CLASSIFICATION OF SOIL ASSOCIATIONS SELECTED AS POTENTIAL LAND TREATMENT AREAS

(1) COUNTY	(2) SOIL ASSOCIATION MAP NO.	(2) NAME	(3) GROSS AREA (ACRES)	(4) DEPTH HORIZ.	(4) DEPTH INCHES	(5) TEXTURE DOMINANT USDA	(6) REACTION pH	(7) EXISTING ORGANIC MATTER (%)	(8) C.E.C. (MEQ/100 GM)	(9) SLOPE (%)	(10) HYDRAULIC CAPACITY INFILTRATION (IN/HR)	(11) HYDRAULIC CAPACITY PERMEABILITY (IN/HR)	(12) AVAILABLE MOISTURE (IN/IN of SOIL)	(13) SUBSTRATUM DEPTH (FT)	(14) SUBSTRATUM MATERIAL	(15) ROCK DEPTH (FT)	(16) PRESENT SEASONAL HIGH WATER TABLE (FT)	(17) PARTICLE DISTRIBUTION % SAND	(18) % SILT	(19) % CLAY	(20) CLASSIFICATION UNIFIED	(21) CLASSIFICATION AASHO	(22) PERCENT PASSING SIEVE No. 4 (4.7mm)	(23) No. 10 (2.0mm)	(24) No. 200 (0.074mm)	(25) SHRINK SWELL POTENTIAL	(26) CORROSIVITY UNCOATED STEEL	(27) CORROSIVITY CONCRETE	(28) TERRAIN CHARACTER	(29) LAND USE CURRENT	(30) VEGETAL COVER	(31) ORGANIC REMOVAL	(32) HEAVY METAL STORAGE CAPACITY
HURON Continued	15	Wilmer	3,400	A	0-18	l, fsl	5.5-6.5			0-3		1.0 - 6.3	0.14-0.17		Till	5+	1 - 2				ML, SM	A-4	80- 95	70- 90	40- 60	Low	---	Low	No Limitations	85% Rural	10% Wooded	Fair	Fair
				B	18-32	scl	5.5-6.5					6.3 +	0.05-0.12								SC, CL	A-2,A-4	70- 90	65- 90	35- 60	Low	Moderate	Low					
				C	32-60	s, g, fsl	6.0-7.0														SM, GM	A-1,A-2	50- 85	50- 85	20- 40	Low	Moderate	Low					
	16	Wooster	2,200	SAME AS FOR SUMMIT COUNTY																									No Limit	85% Rural	10% Wood	Fair	Fair
	27	Mahoning-Ellsworth-Trumbull	111,200	SAME AS FOR MEDINA COUNTY																									No Limiting Factors	90% Rural	15% Wooded	Excellent	Good
LAKE	7	Chili	2,900	SAME AS FOR CUYAHOGA COUNTY																								Some Steep Terrain		90% Urban	20% Wood	Fair	Fair
	17	Chili-	23,600	SAME AS FOR CUYAHOGA COUNTY																								Some Steep Terrain		90% Urban	20% Wood	Fair	Fair
		Colonie		SAME AS FOR ASHTABULA COUNTY																										90% Urban	20% Wood	Fair	Acceptable
	2	Berrien	5,700		0-11	lfs				2-6				4.0	Lacustrine Loam	5+														60% Urban	40% Wood	Fair	Acceptable
					11-50	fs																											
	27	Mahoning-Ellsworth-Trumbull	64,300	SAME AS FOR MEDINA COUNTY																									Few Limiting Factors	70% Urban	Non-urban Heavily Wooded	Excellent	Good
LORAIN	18	Haskins-	36,400	A	0- 8	l or fsl	6.1-6.5	3.8		0-6		0.63- 6.3	0.12-0.18	2.5	Silty Clay or Clay	5+	½ - 1½	38.9	34.7	26.4	ML-CL	A-4	100	90-100	60- 70	Low	---	Low	No Limitations	80% Urban or Occupied By Hi-ways	20% Wooded	Excellent	Good
				A & B	8-18	l	6.1-6.5	0.6				0.63- 2.0	0.16-0.18					38.9	19.2	41.9	ML	A-4	100	90-100	70- 80	Low	High	Low					
				B	18-40	cl	6.1-6.5					0.63- 2.0	0.14-0.18					49.0	20.1	30.9	CL	A-6	90-100	90-100	70- 80	Moderate	High	Low					
				C	40-60	cl	7.4-8.4					0.063-0.2	0.07-0.10					2.1	43.2	54.7	SC or ML	A-4,A-6	85- 95	80- 90	45- 60	Moderate	High	Low					
		Jimtown		A	0-10	l or fsl	5.6-6.0			0-2		0.63- 6.3	0.12-0.18	3.5	Sand & Fine Gravel	5+	< ½				ML	A-4	75- 85	70- 80	65- 75	Low	---	Moderate	No Limitations	Same as above	20% Wooded	Good	Good
				B	10-27	gcl	5 -6.5					0.2 - 0.63	0.16-0.18								ML	A-6	55- 90	75- 85	60- 70	Moderate	Moderate	Moderate					
				B & C	27-60	gl	5 -6.5					0.63- 2.0	0.14-0.18																				
	27	Mahoning-Ellsworth-Trumbull	36,900	SAME AS FOR MEDINA COUNTY																									Flat	85% Rural	20% Wooded	Excellent	Good
MEDINA		Mahoning-		A & B	0-11	sil	4.5-5.5	0.7-2.6	14.7	1-4		0.2 - 0.63	0.19-0.23	3.0	Clay Loam or Silty Loam Till	5+	½ - 1½	18.6	44.2	37.2	ML,ML-CL	A-4, A-6	90-100	90-100	70- 90	Low	---	Low	No Limiting Factors			Excellent	Good
				B	11-32	sicl	4.5-5.5	0.4	21.0			0.063-0.2	0.15-0.18					16.1	38.9	45.0	CL,ML-CL	A-7, A-6	90-100	85-100	70- 90	Moderate	High	Low					
				C	32-74	sicl	7.1-8.0		20.6			<0.063	0.15-0.18					17.7	42.1	40.2	CL,ML-CL		85-100	80- 95	70- 90	Moderate	High	Low					
	27	Ellsworth-	114,600	A	0- 8	sil	4.5-5.0	1.6	13.0	4		0.63- 2.0	0.18-0.22	2.5	Clay Loam or Silty Clay Loam Till	5+	1½ - 3	19.4	60.4	20.2	ML	A-4	90-100	90-100	70- 90	Low	---	Moderate	No Limiting Factors	80% Rural	20% Wooded	Excellent	Good
				B	8-37	sicl	4.5-5.5	0.5	18.3			0.063-0.2	0.16-0.19					17.8	48.4	33.8	CL, CH	A-6,A-7	90-100	85-100	80- 90	Moderate	High	Low					
				B & C	37-60	sicl	[illegible]-6.0		16.6			0.063-0.2	0.16-0.19					27.0	44.9	33.1	CL,ML-CL	A-6	85-100	80- 95	80- 90	Moderate	High	Moderate					
		Trumbull		A	0- 8	sil	4.5-5.5	5.6		1		0.063-0.2	0.15-0.18	3.5	Clay Loam or Clay Till	6+	0 - ½	15.1	51.0	33.8	ML-CL,ML	A-4,A-6	95-100	90-100	70- 95	Low	---	High	No Limiting Factors			Excellent	Good
				B	8-26	sicl	4.5-6.0	0.6				<0.063	0.15-0.18					16.2	48.3	35.3	CL, CH	A-7	90-100	90-100	70- 95	Mod to Hi	High	Moderate					
				B & C	26-60	sicl	5.[illegible]-7.8					<0.063	0.15-0.18					23.4	55.2	25.4	CL,ML-CL	A-6,A-7	95-100	90-100	70- 95	Mod to Hi	High	Mod. to Low					
OTTAWA			--0--																														
PORTAGE	19	Chili-	32,900	SAME AS FOR CUYAHOGA COUNTY																									No Limit	60% Rural	20% Wood	Fair	Fair
		Wheeling		A	0- 8	sil	5.6-6.0	4.2	21.0	1-10		0.63- 2.0	0.17-0.20	4.0	Gravel, Sand & Silt	5+	4+	17.8	68.9	12.9	ML,ML-CL	A-4	95-100	90-100	80- 95	Low	---	Moderate	No Limitations	60% Rural	20% Wooded	Good	Good
				B	8-41	sil	5.1-6.0	0.3	14.0			0.63- 2.0	0.16-0.20					21.9	55.9	22.2	ML-CL	A-4,A-6	95-100	90-100	80-100	Low	Low	Mod to Hi					
				C	41-50	gfsl, cos	4.5-5.0	0.2	7.0			6.3 -12.0+	0.02-0.04					69.4	21.1	9.5	GW,GP, GM	A-1,A-2	30- 65	15- 40	0- 20	Low	Low	Mod to Hi					
	27	Mahoning-Ellsworth	30,200	SAME AS FOR MEDINA COUNTY																									Some Steep Terrain	45% Urban	30% Wooded	Excellent	Good

CLASSIFICATION OF SOIL ASSOCIATIONS SELECTED AS POTENTIAL LAND TREATMENT AREAS

TABLE II - I Sheet 4 of 5

(1) COUNTY	(2) SOIL ASSOCIATION MAP NO.	(2) NAME	(3) GROSS AREA (ACRES)	(4) DEPTH HORIZ.	(4) DEPTH (INCHES)	(5) TEXTURE DOMINANT (USDA)	(6) REACTION pH	(7) EXISTING ORGANIC MATTER (%)	(8) C.E.C. (MEQ/100 GM)	(9) SLOPE (%)	(10) HYDRAULIC CAPACITY INFILTRATION (IN/HR)	(11) PERMEABILITY (IN/HR)	(12) AVAILABLE MOISTURE (IN/IN of SOIL)	(13) SUBSTRATUM DEPTH (FT)	(14) SUBSTRATUM MATERIAL	(15) ROCK DEPTH (FT)	(16) PRESENT SEASONAL HIGH WATER TABLE (FT)	(17) PARTICLE DISTRIBUTION % SAND	(18) % SILT	(19) % CLAY	(20) CLASSIFICATION UNIFIED	(21) AASHO	(22) PERCENT PASSING SIEVE No. 4 (4.7mm)	(23) No. 10 (2.0mm)	(24) No. 200 (0.074mm)	(25) SHRINK SWELL POTENTIAL	(26) CORROSIVITY UNCOATED STEEL	(27) CONCRETE	(28) TERRAIN CHARACTER	(29) LAND USE CURRENT	(30) VEGETAL COVER	(31) ORGANIC REMOVAL	(32) HEAVY METAL STORAGE CAPACITY
RICHLAND	1	Bennington-	17,500	SAME AS FOR ASHLAND COUNTY																									No Limit.	95% Rural	10% Wood	Excellent	Good
		Cardington		SAME AS FOR ASHLAND COUNTY																									No Limit.	95% Rural	10% Wood	Excellent	Good
	20	Belmore-	2,000	A A & B C	0-11 11-46 46-60	l or sl gl gsl	6.6-7.4 6.6-7.4 6.6-7.4	2.2 1.0		2-6		2.0 - 6.3 6.3 -12.0 6.3 -12.0	0.14-0.17 0.09-0.12 0.05-0.10	3.5	Sand & Fine Gravel	5+	3	71.3 75.3 72.7	16.8 10.5 16.3	11.9 14.2 11.0	ML CL,SC SM,SW-SM	A-4 A-6 A-1,2,3	90-100 95-100 65-100	90-100 90-100 65- 75	60- 75 45- 70 6- 35	Low Low Low	--- Low Low	Low Low to Mod. Low	No Limitations	95% Rural	10% Wooded	Fair	Good
		Honey		A B C	0- 7 7-34 34 +	l or sl cl fs, fg, s	6.1-6.5 6.6-7.3 6.6-7.3	4.0		2-6	0.2- >5.0	0.2 - 1.2 0.2 - 0.8 0.2 - 2.5	0.17-0.20 0.16-0.19 0.14-0.18	3.0	Sand & gc below 42"	5+	1½ - 3				ML SC, CL SM, SW-SM	A-4 A-6 A-1,A-2,-3	95-100 95-100 65-100	90-100 85- 95 65- 75	60- 75 40- 60 6- 35	Low Moderate Low	--- Moderate Moderate	Low Mod to Low Low	No Limitations	95% Rural	10% Wooded	Good	Good
SANDUSKY		Oakville-		A C C	0-10 10-22 22-60	lfs lfs fs & lfs	6.1-6.6 6.1-6.6 6.6-7.3			2-6		6.3 + 6.3 + 6.3	0.08-0.12 0.08-0.12 0.04-0.10	4.0	Sand	5+													No Limitations	95% Agricultural	5% Wooded	Fair	Fair
		Belmore-		SAME AS FOR RICHLAND COUNTY																												Good	Good
		Honey-		SAME AS FOR RICHLAND COUNTY																												Good	Good
	21	Wauseon-	55,700	A B C C	0- 8 8-34 34-59 59-70+	lfs lfs fs c or cl	6.5-6.9 6.5-7.2 6.8-7.4	5.5		0-1		2.0 - 6.3 2.0 - 6.3 0.06- 0.2 0.06- 0.2	0.14-0.20 0.08-0.14 0.04-0.12 0.05-0.10	3.5	Lacustrine Clay or Clay Till	5+	0				SM, ML SM ML-CL, CH	A-2,A-4 A-2,A-4 A-6,A-7	95-100 95-100 95-100	90-100 90-100 90-100	25- 55 20- 40 80- 95	Low Low High	High High High	Low Low Low				Fair	Fair
		Digby-		SAME AS FOR HANCOCK COUNTY																												Good	Fair
		Millgrove		SAME AS FOR CRAWFORD COUNTY																												Good	Good
SENECA		Hoskins-		SAME AS FOR LORAIN COUNTY																									No Limit.	95% Agri.	5% Wood	Good	Good
	22	Honey-	41,800	SAME AS FOR RICHLAND COUNTY																									No Limit.	95% Agri.	5% Wood	Good	Good
		Belmore		SAME AS FOR RICHLAND COUNTY																									No Limit	95% Agri.	5% Wood	Good	Good
		Bennington-		SAME AS FOR ASHLAND COUNTY																									No Limit.	95% Agri.	5% Wood	Excellent	Good
		Cardington		SAME AS FOR ASHLAND COUNTY																									No Limit.			Excellent	Good
	1	Pewamo	52,900		0-12 12-34 34-60	sicl, sc sc cl	6.6-7.4 6.6-7.4 7.4-8.4	4.6		0-1		0.063-0.63 < 0.063 0.02 -0.63	0.15-0.21 0.15-0.18 0.16-0.18	3.5	Clay Loam or Silty Clay Loam	5+	0 - ½	18.1 11.3 19.0	38.1 37.9 41.9	43.8 25.8 39.1	ML,MH,ML-CL ML-CL, CH CH	A-6,A-7 A-6,A-7	100 95-100 90-100	100 90-100 80-100	80- 95 80- 95 70- 85	Moderate High Moderate	--- High High	Low Low Low				Excellent	Excellent
STARK			--0--																														
SUMMIT	23	Canfield-	22,200	A B B C	0- 8 8-25 25-55 55-62	sil sil l l	4.6-5.5 4.6-5.5 5.1-6.0 5.6-6.0	2.0 0.5		2-6		0.63- 2.0 0.63- 2.0 0.2 - 0.63 0.2 - 0.63	0.18-0.22 0.17-0.21 0.07-0.10 0.10-0.14	4.5	Loam Till	5+	1½ - 3	16.3 20.7 30.9 34.9	68.4 54.6 45.6 46.4	15.3 24.7 23.5 18.7	ML ML-CL,CL ML-CL,ML ML-CL	A-4 A-4 A-4 A-4	80- 95 80- 95 80- 95 80- 95	80- 95 80- 95 80- 95 70- 95	60- 85 50- 75 60- 70 50- 65	Low Low Low Low	--- Moderate Moderate Low	High High Moderate Moderate		95% Urban		Fair	Fair
		Wooster		A & B B B	0-21 21-40 40-60	sil l l	4.5-6.0 5.1-5.5 5.1-6.0	6.4 0.4 0.3		5-15		0.63- 2.0 0.63- 2.0 0.63- 2.0	0.17-0.20 0.10-0.15 0.07-0.12	3.5-4.0	Loam Till	5+	4+	37.1 43.2 44.7	50.6 38.6 39.2	12.3 18.2 16.1	ML,CL ML,SM ML,SM	A-4 A-4 A-4	76-100 75- 95 75- 95	70- 95 70- 95 70- 95	50- 85 45- 70 45- 70	Low Low Low	Low Low Low	Moderate Moderate Low				Fair	Fair
		Ch[illegible]	27,900	SAME AS FOR CUYAHOGA COUNTY																										95% Urban		Fair	Fair
	27	Mahoning-Ellsworth	46,100	SAME AS FOR MEDINA COUNTY																									No Limiting Factors	80% Rural	50% Wooded	Excellent	Good
TRUMBULL	24	Canfield	3,400	SAME AS FOR SUMMIT COUNTY																									No Limit	95% Agri	10% Wood	Fair	Fair
	27	Mahoning-Ellsworth-Trumbull	44,800	SAME AS FOR MEDINA COUNTY																									No Limitation	80% Rural	50% Wooded	Excellent	Good

CLASSIFICATION OF SOIL ASSOCIATIONS SELECTED AS POTENTIAL LAND TREATMENT AREAS

TABLE II-1 Sheet 5 of 5

(1) COUNTY	(2) SOIL ASSOCIATION MAP NO.	NAME	(3) GROSS AREA (ACRES)	(4) DEPTH HORIZ.	INCHES	(5) TEXTURE DOMINANT USDA	(6) REACTION pH	(7) EXISTING ORGANIC MATTER (%)	(8) C E C (MEQ / 100 GM)	(9) SLOPE (%)	(10) HYDRAULIC CAPACITY INFILTRATION (IN/HR)	(11) PERMEABILITY (IN/HR)	(12) AVAILABLE MOISTURE (IN/IN of SOIL)	(13) SUBSTRATUM DEPTH (FT)	(14) MATERIAL
WOOD		Ottokee-		SAME AS FOR HANCOCK COUNTY											
				A	0-11	lfs	6.4-6.8	2.0		0-1					
		Granby-		B	11-32	fs	6.8-7.0	0.3							
				C	32-37	fs	>7.0								
	25	Seward-	70,000	SAME AS FOR HANCOCK COUNTY											
				A	0-6	fsl	6.6-7.4			2-6		6.3-12.0	0.12-0.16	3.0	Lacustrine
		Rimer-		A	6-14	lfs	6.6-7.3					6.3-12.0	0.10-0.14		Clay or
				B	14-22	fsl, sicl	7.4-7.8					6.3-12.0	0.12-0.15		Clay Till
				B & C	22-60	sicl	7.4					0.2-0.63	0.19		
		Wauseon		SAME AS FOR SANDUSKY COUNTY											
WYANDOT		Henshaw-													
				A	0-10	sil	5.6-6.6	1.5		2-6					
	26	Uniontown-	30,700	B	10-32	sicl, cl	5.0-5.6	0.7							
				C	32-40+	l	7.0								
				A	0-14	cl	6.4	4.6							
		Patton		B	14-29	cl, sicl	6.6-7.0	1.2							
				C	29-73	l, sl, cl	6.8-7.2								
		TOTAL	1,661,700												

(1) COUNTY	NAME	HORIZ.	(15) ROCK DEPTH (FT.)	(16) PRESENT SEASONAL HIGH WATER TABLE (FT)	(17) PARTICLE DISTRIBUTION % SAND	(18) % SILT	(19) % CLAY	(20) CLASSIFICATION UNIFIED	(21) AASHO	(22) PERCENT PASSING SIEVE No 4 (4.7mm)	(23) No 10 (2.0mm)	(24) No 200 (0.074mm)	(25) SHRINK SWELL POTENTIAL	(26) CORROSIVITY UNCOATED STEEL	(27) CONCRETE	(28) TERRAIN CHARACTER	(29) LAND USE CURRENT	(30) VEGETAL COVER	(31) ORGANIC REMOVAL	(32) HEAVY METAL STORAGE CAPACITY
WOOD	Ottokee-																		Fair	Acceptable
	Granby-	B														Flat	95% Agricultural	5% Wooded		
	Rimer-	A	5+																Fair	Fair
	Wauseon																		Fair	Fair
WYANDOT	Henshaw-															No Limit	95% Agri	10% Wood		
		A			36.0	50.6	13.4													
	Uniontown-	B			19.9	43.1	37.0												Excellent	Good
		C			35.0	43.4	21.6													
		A			46.6	39.3	14.1													
	Patton	B			48.4	33.9	17.7												Excellent	Good
		C			60.4	27.9	16.7													

TABLE II-2

EXPLANATION OF COLUMN HEADINGS IN TABLE II-1

Column (1) - Counties lie either partly or entirely with the Lake Erie drainage basin from the western border of Wood County to the eastern border of Ashtabula County.

Column (2) - A soil association consists of one or more soil series and is identified by a map number for ease in locating the soil association on the accompanying map. Soils in a series can differ in texture of the surface soil and in slope, stoniness, etc., and are divided into phases on the basis of these differences.

Column (3) - This column shows the gross area within each particular county for each selected soil association.

Column (4) - The depth refers to the vertical distance below the ground surface for the "A", "B" and "C" horizons.

Column (5) - The soil texture shows the dominant soil texture, or textures, according to the USDA Classification used by the SCS. (See Figure II-3.)

Columns (6) and (7) - These are soil conditions at present and could be affected by land treatment. Organic matter percentages have not been published for all soils.

Column (8) - C.E.C. represents the cation exchange capacity of the soil in milliequivalents per 100 grams of soil. It is a measure of the soil's ability to remove chemicals from irrigation water.

Column (9) - This column gives the range of slope of the ground surface. Some soils such as the Chili soil may have several phases in one association which will differentiate between slopes and sometimes texture.

Columns (10) and (11) - The hydraulic capacity of the soil is a measure of the soil's capacity to accept and transmit water through the soil column.

- Infiltration rate is determined by impounding a 3-inch head of water on a grass-legume sod surface for 24 to 30 hours and measuring the rate, expressed in inches per hour, at which the water continues to enter the ground surface at the end of this period.

- Permeability (percolation) is determined by maintaining a constant water level in an 8-inch diameter hole 12 inches deep, and measuring the rate at which water continues to be absorbed into this test zone after a 40-hour period. (Rate in inches per hour.)

Column (12) - Available moisture is the amount of water available to the plant and represents the difference between field capacity and the wilting point. For best crop results, water should not be depleted below about one-half of the available moisture content. Available moisture is expressed in inch of water per inch of soil.

Columns (13) and (14) - The substratum is the depth to "C" horizon or to the bottom of the subsoil ("B" horizon). In some soils it is the depth to bedrock, and in some instances the depth to the substratum is a good indicator for the maximum depth of tile. Expressed in feet.

Column (15) - Refers to the depth to a rock stratum. The soil associations which were selected do not include bedrock less than 5 feet from the surface, and in almost all cases the bedrock is more than 10 feet deep. Expressed in feet.

Column (16) - Indicates the depth to the seasonal high water table under present conditions. Expressed in feet.

Columns (17), (18) and (19) - These three columns summarize the distribution of the sand, silt and clay particles in the indicated soil layer. These percentages are used to determine the soil texture for Columns (5), (20) and (21).

Column (20) - Indicates the soil textural classes based on the CE Soil Groups. These can be related to the USDA textural classes in Column (5).

Column (21) - Indicates the soil textural classes based on AASHO Soil Groups. These can also be related to the USDA textural classes in Column (5).

Columns (22), (23), and (24) - These columns indicate the grain size distribution of the soil. These distributions are used in soil mechanics to express size uniformity, but have far wider use in sanitary engineering.

Column (25) - The shrink-swell potential of the soil has engineering application in the designing of foundations for buildings, airports and roads. Indicated as low, moderate, or high.

Columns (26) and (27) - Indicate the corrosivity to steel and concrete.

Column (28) - This column cites special terrain features which may limit a soil association's efficacy for use as a treatment site. Erosion, ponds, hummocking and steep slopes are a few such limiting terrain features.

Column (29) - The current land uses are necessarily generalized for use in this tabulation.

Column (30) - Vegetal cover is based generally on published and unpublished data, including maps and photos.

Column (31) - Organic removal is a qualitative indicator of the soil's ability to adsorb soluble or suspended organics added to the soil with irrigation water and is an indicator of the soil's ability to remove residual BOD in this effluent. Designations range from fair in a loamy sand soil to excellent in a silty clay loam.

Column (32) - The heavy metal storage capacity of the soil is an indicator of the physical-chemical ability to adsorb heavy metals. This indicator is also related to the total amount of metals which the soil can store over a long period of time. The soils are rated excellent, good, fair, and acceptable.

FIGURE II-2

STUDY LOCATION MAP
SHOWING COUNTIES IN LAKE ERIE DRAINAGE BASIN
INCLUDED IN SOILS INVENTORY

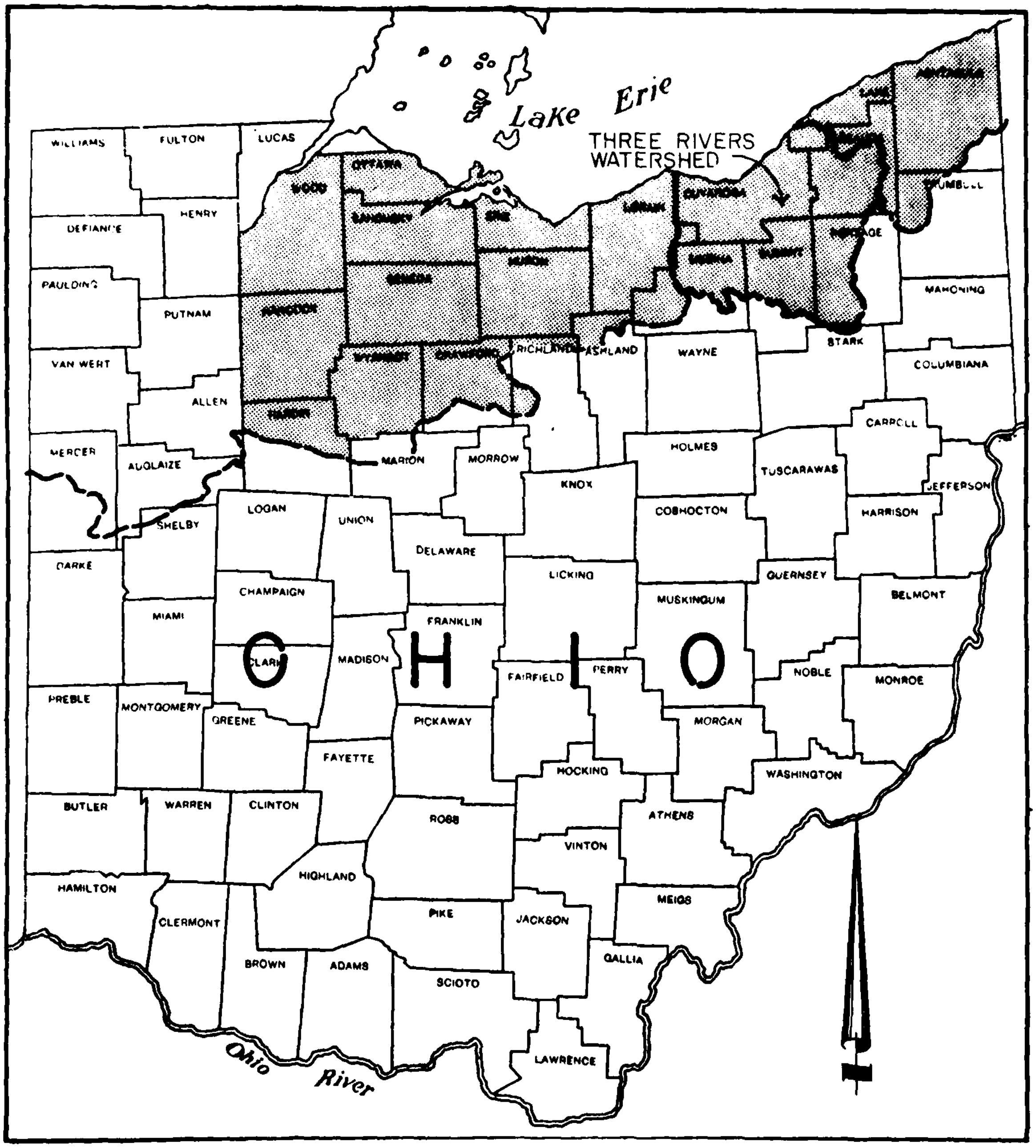
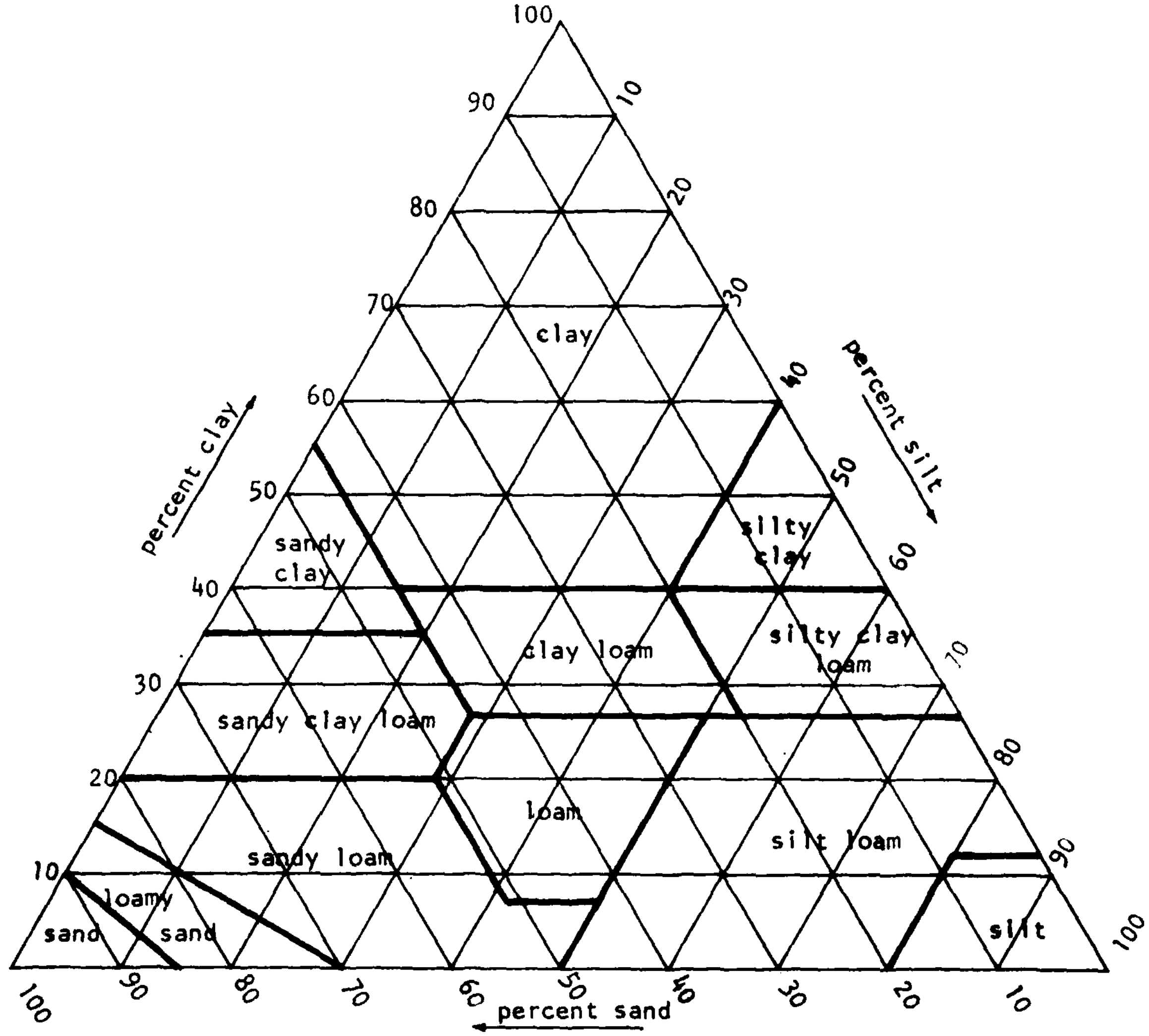


FIGURE II - 3

Column (5)

USDA Soil Textural Classification System



Abbreviations used in Table II - 1:

s	- sand	si	- silt	c	- clay
sl	- sandy loam	sil	- silt loam	cl	- clay loam
scl	- sandy clay loam	sicl	- silty clay loam	l	- loam
sc	- sandy clay	sic	- silty clay	ls	- loamy sand

SECTION III

SOIL DATA SOURCES

It was recognized early in this investigation that the soils and their characteristics would be the basic factor governing the selection of potential land treatment areas. Various local, state and federal agencies conduct soil studies. In the state of Ohio, the Soil Conservation Service of the U. S. Department of Agriculture, the Division of Lands and Soil of the Ohio Department of Natural Resources, and the Ohio Agricultural Research and Development Center are the three main agencies which do agricultural soil field work and classification. Ohio State University also carries out field, technical and laboratory work on soil samples.

COUNTY SOIL MAPS AND REPORTS

Published county soil maps and reports were the first source of data to be reviewed and analyzed; they are listed in the bibliography at the end of this section, and include the following publications: (1) Soil Survey reports, compiled jointly by the three agencies listed above; (2) GeneralSoil Maps, prepared by the Ohio Division of Lands and Soil and the Soil Conservation Service; and (3) the Inventory of Ohio Soils, a series prepared by the Ohio Division of Lands and Soil. These sources supplied the data presented in Table II-1 and in Figure II-1.

SOIL CONSERVATION SERVICE FILE DATA

To provide additional information for the wastewater management study, the state office of the Soil Conservation Service tabulated special soil data for an area bounded by specified counties in the northern

Ohio Lake Erie Basin. This data was supplemented by a map (Figure III-1) showing the approximate limits of the soil associations in this area. Together the map and tables contained consistent, region-wide information not available in published form and provided a dependable check on previously published material.

Each of the soil associations listed in Table III-1 was defined on a standardized form by the SCS in terms of estimated physical and chemical properties as follows:

1. Soil Series and Map Symbol. Series according to SCS classification with appropriate symbol keyed to the SCS soil map, Figure III-1.

2. Depth to Bedrock. In feet.

3. Depth to Seasonal High Water Table. In feet.

4. Depth from Surface of Typical Profile. Depth from soil surface to top and bottom of each soil horizon.

5. USDA Texture. The relative proportions of sand, silt and clay in a soil; this system is used by the SCS.

6. Classification Unified. Engineering classification for soil texture. Soils are grouped on the basis of their texture and plasticity and their performance as material for engineering structures.

7. Classification AASHO. Textural classification system used by the American Association of State Highway Officials.

8. Coarse Fraction (<3"). Particle fraction greater than three inches in diameter.

9. Percent Passing Sieve (No. 4, No. 10, No. 200. Particle size analysis used in engineering classifications (No. 4 - <4.7 mm; No. 10 - 4.7 - 2.0 mm; No. 200 - 2.0 - p.075 mm).

10. Permeability. Steady-state rate of movement of water through soil (inch per hour).

11. Available Water Capacity. The amount of water that is available for plant uptake (between 1/3 and 15 bars) in inches of water per

inch of soil. Also, soil water between field capacity and wilting point.

12. Reaction (pH Value). Soil pH is a function of hydrogen ion activity, which shows acidity or basicity of the soil.

13. Shrink-Swell Potential. Ability of soil to shrink or swell when drying or receiving moisture. (low, medium, high).

14. Corrosivity (Uncoated Steel and Concrete). Corrosion properties of soil with respect to uncoated steel and concrete.

In addition, the SCS data tabulation included these interpretations and definitions for each of the soil associations:

1. Estimated Representative Soils. The component soil series of each soil association mapped as a unit in Figure III-1.

2. Estimated Percent of Association. The percent each soil comprises of the total mapping unit (less than 5% was ignored).

3. Slope Group. Each soil series within the association was given a letter designation:

   A = 0 to 2% - Level
   B = 2 to 6% - Gently sloping
   C = 6 to 12% - Sloping
   D = 12 to 18% - Moderately steep
   E = 18 to 25% - Steep
   F = 25%+ - Very steep

4. C.N.I. Dominant Percent. (C.N.I. = Conservation Needs Inventory) The dominant percent slope for each soil series within the association.

5. Erosion Class. Each soil series within the association was given a symbol as follows:

   0 - No apparent erosion
   1 - Slight erosion; plowlayer mostly surface soil
   2 - Moderate erosion; plowlayer is a mixture of surface soil and subsoil
   3 - Severe erosion; plowlayer is mostly sub-soil
   θ - Disturbed soils in towns and cities as a result of home building, sewer and water line installation, etc.

6. C.N.I. Land Capability Units (L.C.U.) Each soil series was given a number-letter code:

Class (first number)

1 - Soils have few limitations that restrict their use.
2 - Soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.
3 - Soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.
4 - Soils have very severe limitations that reduce the choice of plants, require very careful mangement, or both.
5 - Soils are not likely to erode, but have other limitations, impractical to remove, that limit their use largely to pasture, woodland, or wildlife.
6 - Soils have severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture, woodland, or wildlife.
7 - Soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture, woodland, or wildlife.
8 - Soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife, or water supply, or to aesthetic purposes.

Subclasses (lower case letter following class number)

e - The main limitation is risk of erosion unless close-growing plant cover is maintained.
w - water in or on the soil interferes with plant growth or cultivation (in some soils wetness can be partly corrected by artificial drainage).
s - soil is limited mainly because it is shallow, droughty, or stony.
c - chief limitation is climate that is too cold or too dry.

7. Estimated Rural Land Use (By Percent). The relative percentages of land used for cropland, pasture, forest, and other for each soil series.

The basic soil characteristics, listed on the data sheets and codified on the map, can be used directly in determining potential land areas for spray irrigation purposes. Additional data included on these standard forms may help to define further aspects of land-based systems besides the physical ability of the soil to receive and transmit sewage effluent.

Such items as present land use, soil corrosivity, shrink-swell potential, and texture classifications may be used by soil engineers, land planners, agronomists, storm drainage engineers, and others in final design functions. This important supplemental data testifies to the advanced state of information available in the field of soils and agriculture.

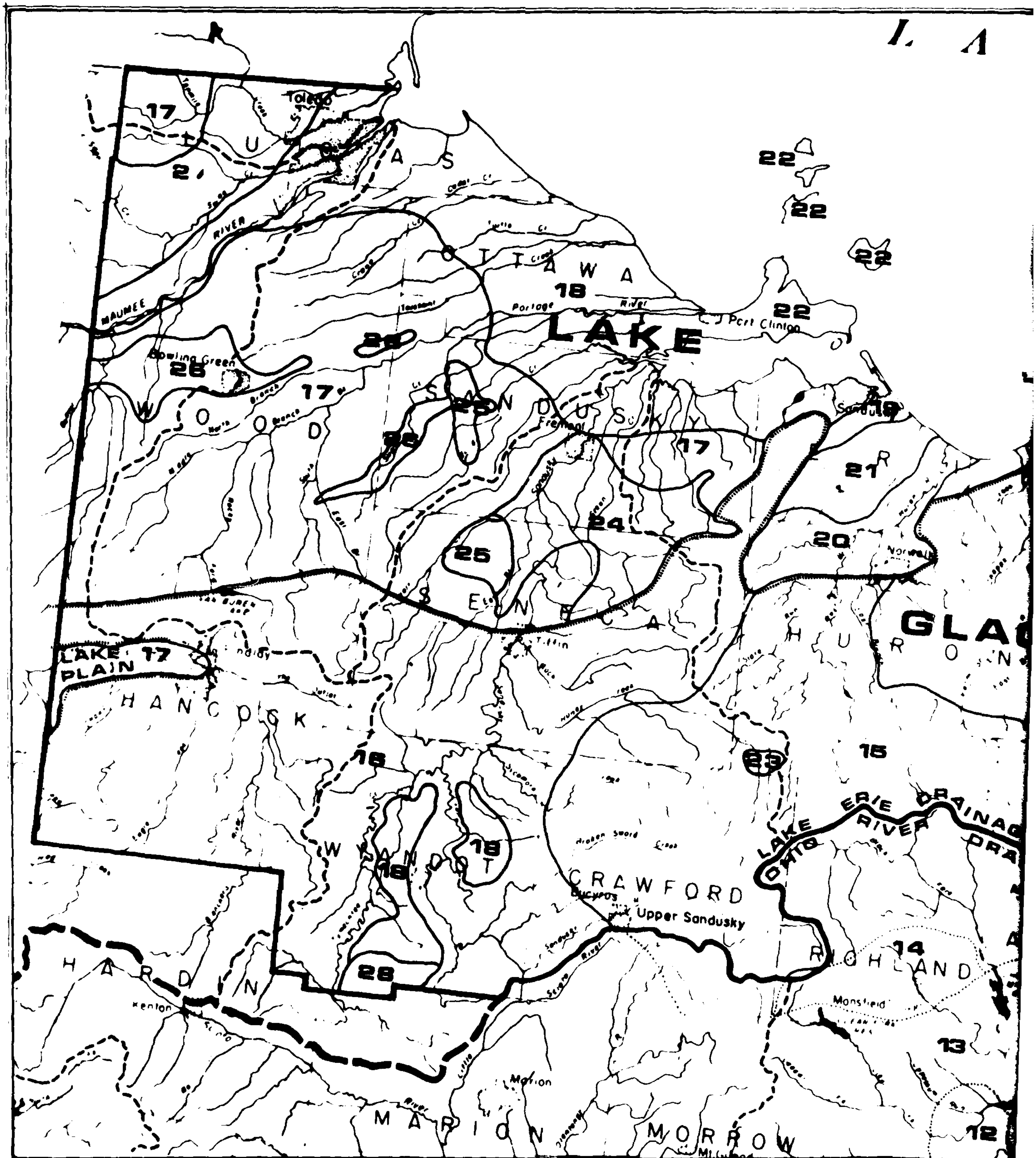
The data from this special SCS tabulation has been presented to a limited extent in Table II-1. The balance of the data is on file for reference. (See Heading IV in the Bibliography for this Section.)

Table III-1 lists the SCS soil associations and the related key map numbers; the map follows in Figure III-1.

TABLE III-1

AREAS OF VARIOUS SOIL ASSOCIATIONS
AS SHOWN ON BASE MAP (Figure III-1)

Map No.	Soil Association	Area (Sq. Mi.)	Area (Acres)
1	Mahoning-Ellsworth	575	368,000
2	Mahoning-Ellsworth Remsen	796	509,000
3	Wadsworth-Rittman	533	341,000
4	Canfield-Ravenna	160	103,000
5	Conneaut-Canadice-Caneadea	342	219,000
6	Canadice-Sebring	88	56,000
7	Chili-Wheeling-Carlisle	177	113,000
8	Otisville-Elnora-Chenango	240	154,000
9	Welkert-Loudenville	30	18,900
10	Sheffield-Platea	497	318,000
11	Berks-Muskingum		
12	Hanover-Muskingum		
13	Wooster-Canfield		
14	Rittman-Wadsworth	2	1,090
15	Cardington-Bennington-Marengo	655	484,000
16	Blount-Pewamo-Morley	1,150	734,000
17	Hoytville	977	626,000
18	Toledo-Fulton-Lenawee	574	372,000
19	Del Rey-Lenawee	14	9,270
20	Kibbie-Tuscola-Colwood	89	56,900
21	Lewisburg-Arkport	58	36,900
22	Lewisburg-Castalia-Millsdale	41	26,200
23	Carlisle	5	3,290
24	Haskins-Haney-Belmore	134	85,500
25	Millsdale-Randolph	39	25,900
26	Wauseon-Ottokee-Spinks	80	50,600
27	Tedrow-Ottokee-Spinks	136	87,200
28	Paulding-Roselms	18	11,700
Total		7,410	4,810,450



L A
LAKE
OTTAWA
SANDUSKY
SENECA
WOOD
HANCOCK
WYANDOT
CRAWFORD
HARDIN
MARION
MORROW
HURON
LAKE PLAIN
Toledo
Bowling Green
Fremont
Tiffin
Port Clinton
Norwalk
Bucyrus
Upper Sandusky
Kenton
Marion
Mansfield
MAUMEE
RIVER
Portage
River
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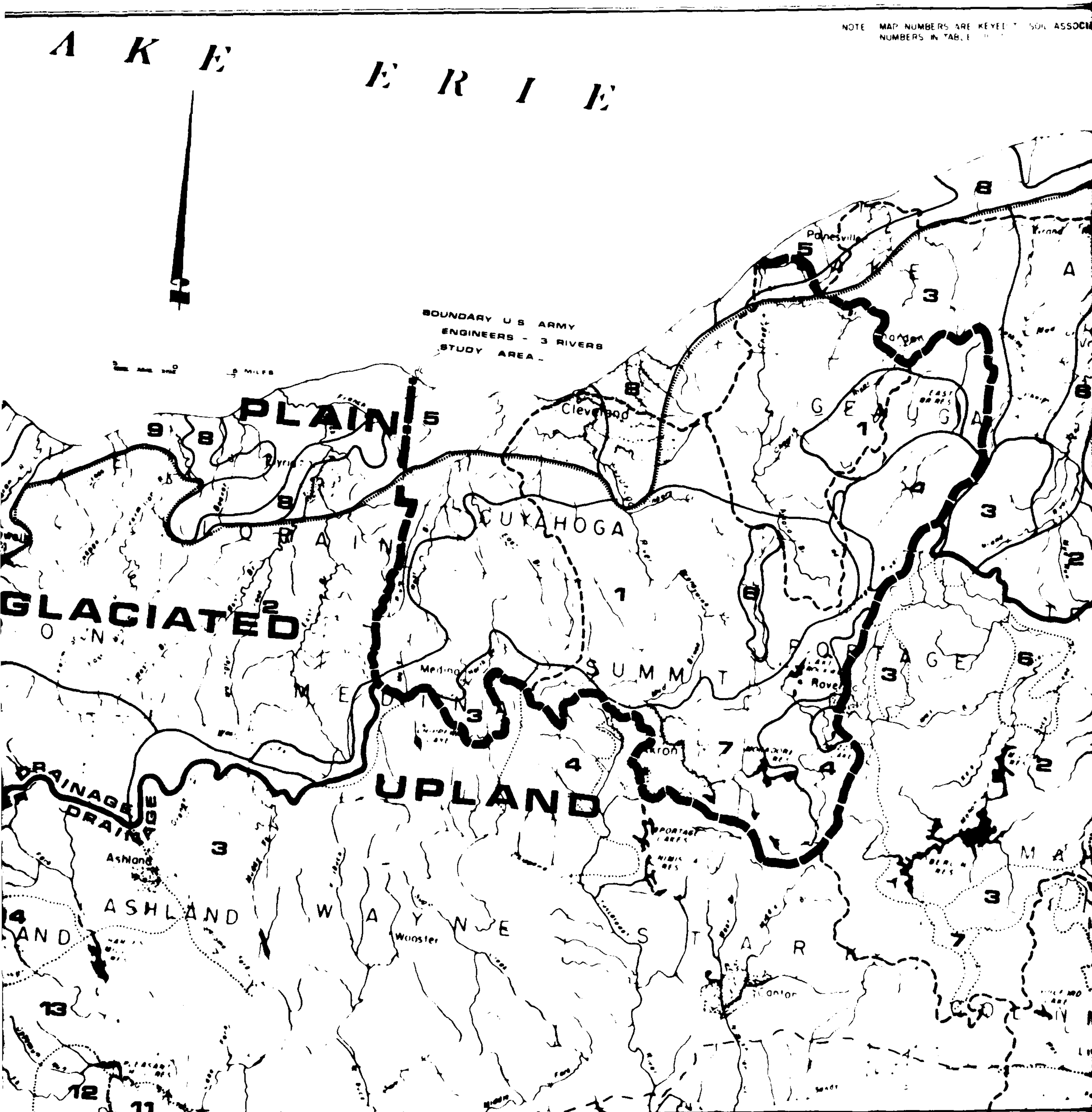
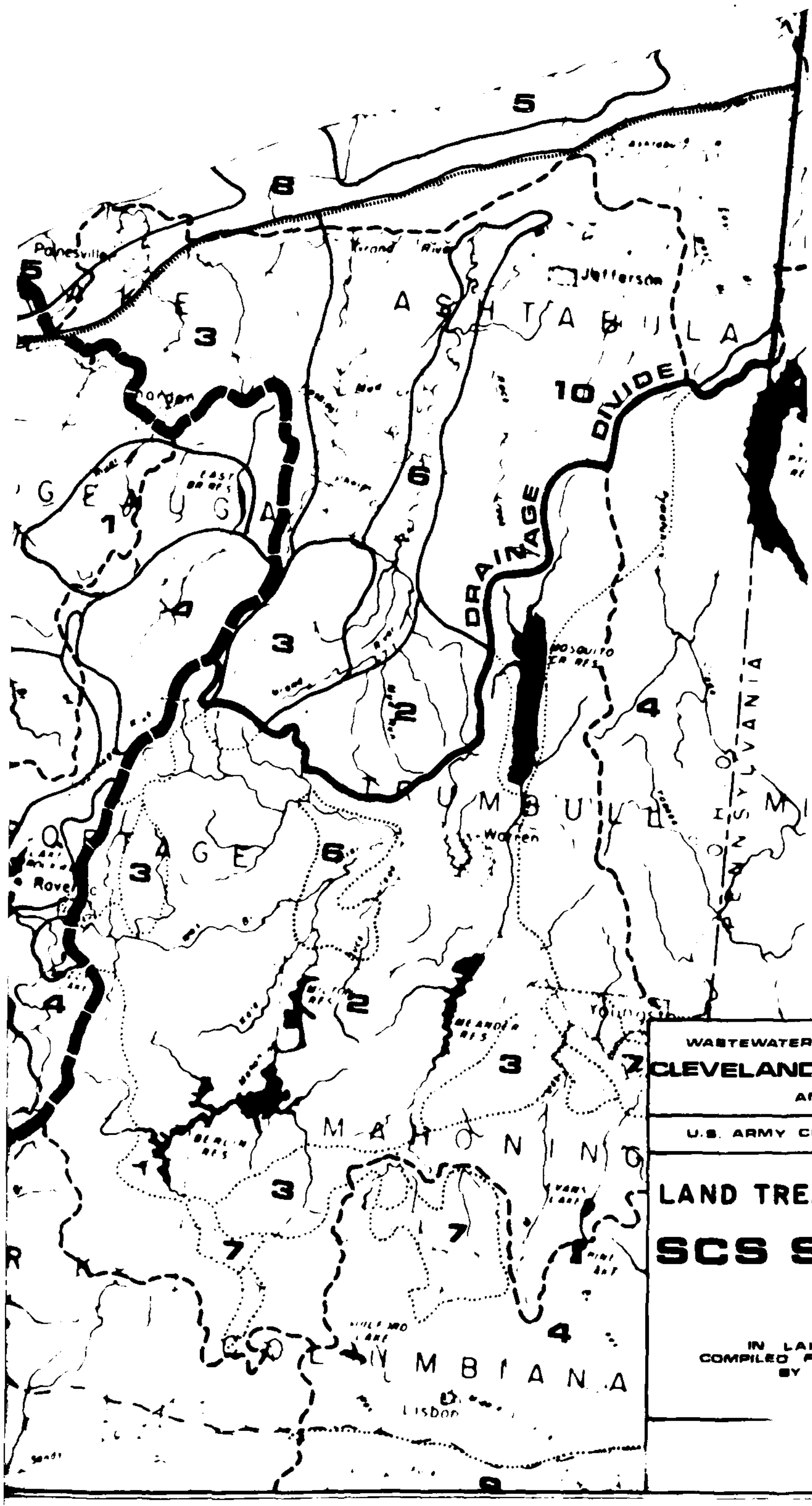


NOTE MAP NUMBERS ARE KEYED TO SOIL ASSOCIATION NUMBERS IN TABLE
A K E
E R I E
BOUNDARY U S ARMY ENGINEERS - 3 RIVERS STUDY AREA
MILES
PLAIN
GLACIATED
UPLAND
DRAINAGE
CUYAHOGA
SUMMIT
GEAUGA
PORTAGE
MEDINA
ASHLAND
WAYNE
STARK
Painesville
Cleveland
Elyria
Medina
Akron
Ravenna
Ashland
Wooster
Canton

.7

NOTE: MAP NUMBERS ARE KEYED TO SOIL ASSOCIATION NUMBERS IN TABLE III-1



WASTEWATER MANAGEMENT SURVEY SCOPE STUDY

CLEVELAND-AKRON METROPOLITAN AREA

AND THREE RIVERS WATERSHED

U.S. ARMY CORPS OF ENGINEERS — BUFFALO DISTRICT

LAND TREATMENT —— PHASE I REPORT

SCS SOIL ASSOCIATION MAP

IN LAKE ERIE BASIN OF NORTHERN OHIO
COMPILED FROM PUBLISHED AND UNPUBLISHED DATA
BY THE SOIL CONSERVATION SERVICE

FIGURE III-1

3

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IV. INFORMATION TABULATED BY RALPH MEEKER, SOIL SCIENTIST, SPECIALIST, OF THE U. S. SOIL CONSERVATION SERVICE AT COLUMBUS, OHIO.

(The generalized soil map and legend (our Figure III-1) for Northern Ohio was compiled by the U. S. Soil Conservation Service. Sources of information used in compilation include C.N.I. data, published soil surveys, soil survey manuscripts, SCS Soil Handbooks, general soil maps of counties published by the Division of Lands and Soil O.D.N.R., and communications with professional Soil Scientists working in the area.)

SECTION IV

GEOLOGY

The geology of the study area, with special emphasis on the potential western land treatment area, is discussed in this section. Certain aspects of the subject, especially the regional glacial geology, and the bedrock underlying Cleveland, require a more detailed geological interpretation; the reader is directed to references in the bibliography of this section.

The area-wide geology is significant to land treatment studies for several primary reasons. In the first place, underground tunnels constructed with mole machines are proposed to transport efficiently large amounts of sewage effluent without disrupting surface features. Secondly, underground mined storage for storm runoff and combined sewage can be economically constructed in shale using mining techniques. Geology also controls to a large extent the type of subsurface drainage needed in the irrigated fields.

This section includes detailed discussions of bedrock stratigraphy, the surface mantle of glacial till and their implications for tunnels, reservoirs and irrigation. The geologic conditions in most of the area are generally favorable for the structures contemplated and would tend to minimize downward percolation of water from either reservoirs or irrigation operations, if properly sited and constructed.

Three major features of the Western Land Treatment Area are the layer of glacial till, which blankets most of the area with a relatively impervious mantle of variable depth generally within the range of 0 to 100 feet;

the system of shale and sandstone bedrock, which underlies the eastern portion of the study area and would provide a very favorable environment for tunneling, as well as a tight substratum for reservoirs and irrigation areas; and, third, the system of limestone and dolomite bedrock, which underlies the western portion of the study area and could pose problems both for tunneling and for storage and irrigation facilities due to systems of fissures and sink holes near the surface. Where irrigation is contemplated over limestone bedrock, careful studies will be necessary to further establish the depth and permeability of the glacial till in each locality.

Data for this preliminary geological investigation have been based upon publications of the Ohio Department of Natural Resources and studies by consulting engineers and geologists as tabulated in the bibliography.

PHYSIOGRAPHY

The Lake Erie Basin of northern Ohio lies within two physiographic provinces: the Appalachian Plateau and the Central Lowlands. The Appalachian Plateau, comprising the eastern half of Ohio, slopes to the west; it is deeply incised by winding stream valleys and is characterized by considerable local relief and steep hillsides. The portion of this plateau within the Lake Erie Basin has been glaciated in the past, consists of rolling hills and valleys, and has somewhat more fertile soils than the unglaciated southern portion of the plateau. The Central Lowlands, comprising the western half of Ohio, slope to the west, are made up mainly of plains interrupted by low morainal ridges, are covered by surficial deposits from past glaciation, and have fertile soils.

The major geologic influences in Ohio can be briefly summarized as follows: The bedrock of the eastern half of Ohio is composed predominantly of old-aged sandstone which is very resistant to erosion. The bedrock of the western half of Ohio is composed predominantly of old-aged limestone which is easily eroded. Preglacial erosion over millions of years wore down the limestone to a plains area and left the more resistant sandstone as hills. Glaciers, which covered the bedrock formations in the western and northeastern portion of Ohio in relatively recent times, modified the terrain, deposited a mantle of glacial drift over the land and buried preglacial river valleys as they receded. Present Ohio streams, flowing in post-glacial channels, continue to alter the existing landscape. Soils weathered from the sandstone bedrock in southeastern Ohio tend to be less fertile than those derived from the limestone glacial drift, which are suitable for agriculture.

STRATIGRAPHY

All sedimentary bedrock formations in northern Ohio were formed within the Paleozoic Era, which dates from 225 million to 600 million years ago. These sandstone, shale, and limestone formations were originally deposited in horizontal layers. (In Wyandot County, at the shallowest point in the study area, the combined thickness of these sedimentary layers is 2,800 feet; elsewhere in Ohio it reaches 10,000 feet.) Regional uplifts, in particular the Cincinnati Arch, which transverses western Ohio from the northeast to the southwest, have tilted the horizontal layers slightly. Therefore, formations to the west of the Cincinnati Arch slope to the

west while those formations to the east of the arch slope to the east. The gradual dip to the east continues to a structural trough which lies parallel to the Appalachian Mountains in West Virginia and Pennsylvania. The study area east of Fremont and Tiffin near the crest of the Cincinnati Arch is, therefore, underlain by eastward dipping formations.

Much of the structure in Ohio is masked by erosion at the surface and by deposition of surficial materials, which generally conceal the underlying rocks. The largest fold in Ohio is a north-plunging portion of the Cincinnati Arch, called the Findley Arch. It is a broad, low fold with the formations dipping away from the axis toward the Appalachian syncline in the east. The anticlinal axis and the synclinal axis extend northeast-southwest. Due to the anticline/syncline relationship, the formations tend to thicken in an easterly direction. The oldest rocks exposed along the Findley Arch are of the Logan Group. The regional dip is in the neighborhood of eleven to twelve feet per mile in a southeasterly direction. However, locally, dips of up to 53 feet per mile have been recorded. Although some intraformational slumps have been reported with movements of a few hundred feet, no major fault systems are thought to exist in the study area.

The Paleozoic Era can be subdivided into the Cambrian (500-600 million years ago), Ordovician (440-500 million years ago), Silurian (400-440 million years ago), Devonian (350-400 million years ago), Mississippian (310-350 million years ago), Pennsylvanian (270-310 million years ago), and Permian (225-270 million years ago) Periods. Bedrock formations from the Silurian, Devonian, Mississippian, and Pennsylvanian Periods are

present directly beneath the surficial deposits of northern Ohio. The following paragraphs describe the physical and hydrologic properties of the various groups of rock laid down during these four periods. The order of discussion is from the oldest to youngest, or from the bottom upward through successively more recent layers, which corresponds to a sequence of appearance at the surface from west to east across the study area, since the formations dip to the east (See Figures IV-1 and IV-2.)

SILURIAN SYSTEM

Lockport Group. The oldest rocks exposed in the western land treatment area belong to the Lockport Group, which is the uppermost group of the Niagran Series and overlies the Clinton Group. The Lockport Group includes the Gasport, Goat Island, and Guelph Formations in the south, but, in the north, the group is not easily separated due to the similar lithologies of the formations.

The rock is highly crystalline, open and porous in texture, and of light color. The formation is always massive in structure with very few well-defined partings. The constitution and physical properties of the dolomite favor the storage of water. When exposed at or near the surface, the rock decays to an open, porous, even cavernous, texture favorable to the accumulation of water. The Lockport Group varies from 120 to 520 feet in thickness.

Salina Group. The Salina Group, composed of the Greenfield and Tymochtee Formations, was formerly assigned to the Bass Island Group. The Greenfield Formation, with few exceptions, is true dolomite in composition and ranges

FIGURE IV-1

VERTICAL SEQUENCE OF BEDROCK FORMATIONS IN NORTHERN OHIO

System	Group	Formation	Material
Quaternary		Glacial Drift & Till	
		UNCONFORMITY	
Pennsylvanian		Pottsville	
		UNCONFORMITY	
Mississippian		Maxville	Limestone
		Logan	Sandstone Shale
		Cuyahoga	Sandstone Shale
	Waverly	(Sunbury	Shale
		(Berea	Sandstone
		(Bedford	Shale
		UNCONFORMITY	
Devonian	Ohio Shale	(Cleveland	Shale
		(Chagrin	Shale
		(Huron	Shale
		UNCONFORMITY	
	"Olentangy" Shale	(Prout	Shale
		(Plumb Brook	Shale
		Delaware	Limestone
		Columbus	Limestone & Dolomite
		UNCONFORMITY	
	Detroit River	(Lucas	
		(Sylvania	Sandstone
		Bois Blanc	Limestone & Dolomite
		UNCONFORMITY	
Silurian	Bass Islands	(Raisin River	Dolomite
		(Put In Bay	Dolomite Shale
	Salina	(Tymochtee	Dolomite
		(Greenfield	Anhydrite
		UNCONFORMITY	
	Lockport	(Guelph	Limestone
		(Goat Island	Limestone
		(Gasport	Limestone

from 175 to 225 feet in thickness. In general, the rock is dense and hard, but some layers are decidedly granular. The beds vary from a definite flaky layer to massive strata of many feet, but generally range from a few inches to two feet in thickness.

The Tymochtee Formation varies in thickness from 125 to 175 feet and consists of thin to massive beds and of considerable thin, flaky material. The lithology varies both areally and vertically but is primarily dolomite. Physically, it varies from close-grained, tough, homogeneous rock to coarse, cavernous stone. It is used to some extent for lime burning and mainly for crushed rock products. The thin-bedded, highly laminated, and much-jointed character of the Tymochtee Formation favors ground water storage. Fissures and cavernous openings are not uncommon in the zone of water circulation.

The Bass Islands Group. The Bass Islands Group, which formerly included the present Salina Group, is equivalent to the old lower Monroe Group. The Put-in-Bay Formation, the lower unit of the Bass Islands Group, is composed of dolomite of fair purity and is gray to light brown in color. The bedding is thin to massive. Where appearing at the surface or under shallow cover, the rocks are much broken by joint bedding plains and solution cavities. This texture makes the Put-in-Bay Formation a fair source for ground water.

The uppermost division in the Bass Islands Group is the Raisin River Formation. The dolomite varies in color from bluish-gray to brownish-gray and is regularly bedded, the layers being two to six inches in thickness. However, locally more massive strata may be encountered.

The formation, due to the unconformity under the Bois Blanc Formation, varies in thickness from location to location. Due to the grainy texture of dolomite, the thinness of the beds, and the numerous joints, the Raisin River Formation, where appearing near or at the surface, is water-bearing.

DEVONIAN SYSTEM

The Bois Blanc Formation saddles the Silurian/Devonian boundary and overlies the Raisin River Formation, where present. The rock is composed of limestone, dolomitic limestone with chert nodules, and dolomite. The formation varies in thickness from 60 feet in Erie County to 140 feet in Cuyahoga County.

The Detroit River Group. The Detroit River Group, overlying the Bois Blanc Formation, is referred to as the upper Monroe in early literature. It is not present to any great extent in the area due to the unconformity below the overlying Columbus Formation. In the South Birmingham Pool area, the Detroit River Group has been included with the Columbus Formation. In this area, the Detroit River Group consists of gray to brown, fine to coarsely crystalline limestones and dolomites. At the base of the group there is generally a white, medium-grained sandstone designated the Sylvania Formation.

The Columbus Formation. The Columbus limestone overlies rocks from the Detroit River Group to rocks of Silurian age. In general, the Columbus strata is massive in bedding and somewhat earthy in appearance. The composition changes with locality and with different layers. It varies

from a magnesium limestone in the upper portion to dolomite in the lower part. The formation, where normally developed, ranges from 80 to 125 feet in thickness. The limestone and dolomitic deposits are regular but rather widely jointed. Through solution, these joints are often opened into fissures that lead to sink holes and underground passages. This characteristic accounts for the many springs, some of large size, associated with the formation.

The Delaware Formation. The overlying Delaware Formation ranges from 30 to 70 feet in thickness. It varies in character from shales with thin limestone layers to rather massive limestone with only bedding plain partings of shale matter. The composition is that of an impure limestone. In general, the Delaware limestone is too hard and dense to act as a reservoir for ground water storage. However, at the surface, weathering and solution open up the deposits sufficiently for the accumulation of small ground water supplies.

The Olentangy Formation. The Olentangy Formation, lying above the Delaware limestone and below Ohio shale, is gray, siliceous, calcareous shale with plastic clay-like properties. Because of the unconformity below the Ohio shale, the formation is not present in all localities.

The Ohio Formation. The Ohio Formation is a thick mass of shales in the upper part of the Devonian System and is composed of the Huron, Chagrin, and Cleveland Members. The Huron and Cleveland Members are typical black or brownish-black fissile shales with a high carbonaceous content. The Chagrin Member is a gray siliceous shale differing from the others by the lack of carbonaceous material. The Ohio shale produces very little, or

no water. About the only water absorption is along the joint and bedding plains in the zone of weathering at or near the surface.

MISSISSIPPIAN SYSTEM

The Waverly Group. The Mississippian System has at its base the Waverly Group, composed of the Bedford,Berea, and Sunbury Formations.

The Bedford Formation. The Bedford Formation is the oldest formation of the Mississippian System and is the beginning of a large series of siliceous deposits, including a variety of shales and sandstones in the Waverly Group. The formation is made up largely of shale, which varies in character. In the Cleveland area, a group of sandstone layers, known as the Euclid Lentil, appears in the basal portion of the formation. Generally there is little or no ground water in the Bedford Formation.

The Berea Formation. The middle formation in the Waverly Group is the Berea sandstone. The sandstone deposits vary considerably in thickness and character. In this area of northern Ohio there are thick deposits of medium coarse-grained, open in texture, massively structured sandstones. The sand grains are rather fine and uniform in size. The cementing agent, consisting largely of clay matter and iron minerals, is from ten to twenty percent of the whole and gives the sandstone excellent strength characteristics. The Berea sandstone is considered a good aquifer and is responsible for many springs of small size.

The Sunbury Formation. The Sunbury Formation is the uppermost formation of the Waverly Group. This shale formation is high in carbonaceous matter, black to brown in color, and fissile to laminated in structure. The small

quantities of water produced from the formation are usually contaminated with salts.

The Cuyahoga Formation. The Cuyahoga Formation, overlying the Waverly Group, is highly variable, both laterally and vertically. Generally the formation consists of interbedded shales and sands. The sandstone, averaging from one to three inches in thickness, is fine-grained and often very micaceous. The shales are also micaceous and usually fissile and very soft. Generally, the Cuyahoga Formation is not a good water producer.

The Logan Formation. The Logan Formation is like the Cuyahoga, which it overlies, in that it consists of interbedded shales and sandstones. The shales are generally blue-gray, but locally change to reddish-brown. In most areas, the sandstone has a finer grain than that of the Cuyahoga.

Through crustal movements and erosion, the Maxville limestone is usually absent in the study area. Where present, the limestone appears to be massively bedded, but, in reality, it is broken every few inches by a papery parting of calcareous shale.

PENNSYLVANIAN SYSTEM

The basal unit of the Pennsylvanian System is the Pottsville Formation, which unconformably overlies the Maxville and older Mississippian formations. In eastern Ohio, vast mineral resources are extracted from the Pottsville Formation. However, in the study area, the Pottsville Formation is found only in small patches and has little economic significance.

ECONOMIC SIGNIFICANCE OF SEDIMENTARY DEPOSITS

The sedimentary deposits in northern Ohio are high in mineral resources. Following is a list of the formations and the minerals or building materials that are derived from them.

From the Guelph Formation oil and gas are produced. Also, limestone quarries are abundant in the study area.

The Greenfield Formation produces road metal, railroad ballast, and concrete aggregate from deposits near the surface.

The Tymochtee Formation of the Salina Group produces large quantities of mined salt.

The Raisin River Formation produces salt brines from bore holes.

The Delaware limestone is often used for building material.

The Bedford shale is also used as a building stone.

The Berea sandstone formation not only produces oil and gas wells, but is used for abrasives and building stone.

The Maxville limestone is commonly used for Portland Cement.

The Pottsville Formation, probably absent in the study area, is a good coal producer.

TUNNELING

One proposed means of transporting treated sewage effluent from load points in the Cleveland and Akron areas to land treatment sites in western Ohio is by a deep tunnel, which might range in diameter from eight to twenty feet. This preliminary investigation has been made in part to determine the major geological conditions along typical tunnel routes and to formulate preliminary opinions concerning the impact of the conditions on tunnel design and construction. The routing considered most applicable

for this project is the third to be described below as the Unified Effluent Transmission Tunnel.

Three potential tunnel alignments have been reviewed. One would extend from the Akron area westward to northwestern Ashland County. The second tunnel route would follow a course from Cleveland to Elyria and from Elyria to northeastern Seneca County. The third tunnel route would extend from Eastlake in Lake County along the Lake Erie shoreline to Cleveland and then west-southwest to the centralized western land treatment area at the "four-corners" of Huron, Richland, Crawford and Seneca Counties.

The Akron Tunnel. The first and southernmost of these three potential tunnel routes would originate near the Akron Sewage Treatment Plant in the Cuyahoga River valley, where a buried valley filled with glacial till cuts into the shale and sandstone bedrock to a possible depth of 450 feet. West of the load point, Missisippian-age shales with a few interbedded sandstones, mainly of the Logan and Cuyahoga Formations, dip gently eastward along the tunnel route and generally constitute bedrock to tunnel depth and below. The tunnel might intercept several one to two-mile sectors of the overlying Pennsylvania-age Pottsville Formation, comprising interbedded sandstones, shales, and coals, depending upon the tunnel invert elevation. Both the sandstones and the shales should be moderately-well to well lithified below the zone of weathering, which should not extend to tunnel depth. Some of the sandstones may be massively bedded, but, for the most part, both the shales and the sandstones are thin-bedded

and are massively jointed. These are essentially competent rock, but the shales may air slake unless protected.[13]

There is no record of faults along the tentatively proposed alignment, but it is possible that at least minor faults could be concealed beneath the mantle of glacial till, outwash, and lacustrine sediments. These faults, however, should incorporate only narrow zones of broken or gougy rock, and should not significantly influence tunneling.

There appear to be no unusual or especially difficult geological conditions along this potential tunnel route. Light rock supports, such as rock bolts or shotcrete, probably will be required to prevent rock slabbing across the tunnel crown in the well-bedded sedimentary rocks, and the tunnel probably will have to be lined because the shales otherwise could deteriorate in a relatively short time, due either to the hydraulic or chemical action of the effluents.[13]

Ground water inflows should be nominal, but it would be reasonable to expect flush flows on the order of several hundred gallons of water per minute from localized zones of fractures and joints.

Rock conditions appear to favor tunneling by a mechanical boring machine. The shales should be relatively dry, and should have relatively low compressive strength, thus being easy to drill. They should also have low abrasiveness, so that drilling bit wear should be relatively low. The sandstones would be relatively easy to bore also, but the bit wear could be substantially increased due to the greater abrasiveness of the quartzose sands of these sandsone units.

In summary, tunneling along this or geologically similar routes should be relatively fast and easy, and costs should not be escalated by severely adverse geological conditions.[13]

<u>The Cleveland-Seneca County Tunnel.</u> The second potential tunnel system would collect effluent from the Cleveland metropolitan area and would carry it west-southwest from Cleveland across Lorain County to areas in Seneca County.

Shales of the Devonian-age Ohio Formation and the Mississippian-age Bedford Formation constitute bedrock across most of the tunnel route to depths in excess of 1,000 feet. Locally, erosional remnants of the Mississippian-age Berea sandstone cap the Bedford shale. The initial fifteen miles of the tunnel would be in the Ohio shales, but the terminal 45± miles would extend in part through Bedford shales and in part through Berea sandstones.[12] The shales range from soft to moderately hard, are thin-bedded to fissile, and, in general, are massively jointed. The Berea sandstone is fine-grained, thin to massively bedded, commonly massively jointed, and moderately well lithified.

Some buried valleys have been discovered during the course of water well drilling in northern Ohio, but it seems possible that others, still undiscovered, could intersect the tentatively proposed tunnel alignments. Tunneling through these deposits could be especially difficult and expensive, due to ground water and tunnel support problems. Thus, it would be important to locate these trenches and avoid them if possible.[12]

Rock conditions appear to be almost ideal for tunneling with a mechanical boring machine (mole) because the rock, mainly shale, should be relatively soft (low compressive strength), dry, and have low abrasiveness. More important, possibly, the rock to be bored would have a relatively narrow range of physical characteristics. Boring machines commonly have a difficult time coping with widely diverse rock conditions.

Both the sandstones and the shales should require only light supports. Rock bolts probably would be appropriate through the sandstone-crowned sectors, but shotcrete could be a better choice in the shale sectors because it would also protect the shale from exposure to the air, which would help to minimize air slaking. Structural steel ribs would be needed only through a few short sectors of the rock, but would be needed throughout any sections that penetrate unconsolidated sediment-filled buried valleys.[12]

Although the tunnels may be below the regional ground water table, water inflows to the tunnels should be low. Shales characteristically are more likely to be aquicludes than aquifers; thus, the rock through long sectors of these tunnels may be essentially dry. Flows of water issuing locally from fracture zones in the shales could peak as high as 50 to 100 gallons per minute, but flows of that magnitude would not create a significant tunneling problem. Similarly, the sandstones of the Berea Formation reportedly are relatively tight and yield only small volumes of water to wells in the project area, probably from joints and fractures. Ground water inflows to the tunnel from these sandstones should be somewhat higher than anticipated from the shales, but probably would not exceed,

on the average, more than a few tens of gallons per minute per 1,000 lineal feet of tunnel.[12]

The tunnel, if extended far enough west, could cross out of the Ohio into the Delaware and ultimately into the Columbus Formation. The Columbus Formation comprises medium to massive-bedded, cherty, finely-crystalline limestone and dolomite. The Delaware Formation in this area of north-central Ohio consists of thin-bedded, cherty limestone, with a few thin interbeds of shaly limestone and limey shale. Both the Columbus and Delaware limestones are utilized for building stone and are described as dense, tough, and durable.[14]

Limestones have been machine-bored successfully, both in Chicago and St. Louis, as well as other areas more geographically remote from the Cleveland area. Probably both the Delaware and Columbus limestones would be similarly boreable. The cherty units would be quite abrasive; thus, bit-wear in them would be considerably higher than in the relatively chert-free units of the limestone, but, otherwise, there would be no unusual problems.

Since the limestones might deteriorate as a result of either chemical reaction with the effluent or as a result of hydrologic erosion, the tunnel would be lined. Although the limestones are competent rock and should be self-supporting in large measure, the rock across the tunnel crown might require at least intermittent light support, such as rock bolts, to minimize slab-type fallouts. Locally, shotcrete or gunite might be used to support sectors of interbedded shaly limestone and limey shales and to minimize air slaking of the shales as much as possible.[14]

Water inflows from the limestones to the tunnel bore could be large, especially from the Columbus Formation, which reportedly yields moderate supplies of water to wells from open fissures, sink holes, joints, and other underground passageways. For early planning, flush flows on the order of 500 gallons per minute should be anticipated.

Similar shales and limestones have been tested to determine compressive strengths and the results published. These published test results indicate a range of 8,000 to 32,000 psi for limestones and 5,000 to 14,000 psi for shales. The Delaware and Columbus limestones, reportedly tough and durable, probably have compressive strengths of the order of 12,000 to 25,000 psi. The Logan Cuyahoga, and Ohio shales are moderately well lithified, and may have compressive strengths of the order of 8,000 to 12,000 psi. The Bedford shale, less well lithified than its neighbor shales in the stratigraphic sequence, probably has compressive strengths ranging from 5,000 to 8,000 psi.[14]

THE UNIFIED EFFLUENT TRANSMISSION TUNNEL

The tunnel alignment would traverse the Lake Erie shoreline from near Eastlake to a load point at the present Cleveland Westerly Sewage Treatment Plant and then follow a line southwesterly across Cuyahoga, Lorain and Huron Counties to a centralized winter storage reservoir site near the southwest corner of Huron County. This route lies between the two tunnel alignments described above and would penetrate similar bedrock formations. The only major difference between the route discussed for the Cleveland-Seneca County Tunnel and the Unified Effluent Transmission

Tunnel route is that the latter is somewhat shorter and terminates farther to the south, so that it probably would be able to remain in the relatively more favorable shale tunneling environment, rather than extending into limestone.

STORAGE RESERVOIRS

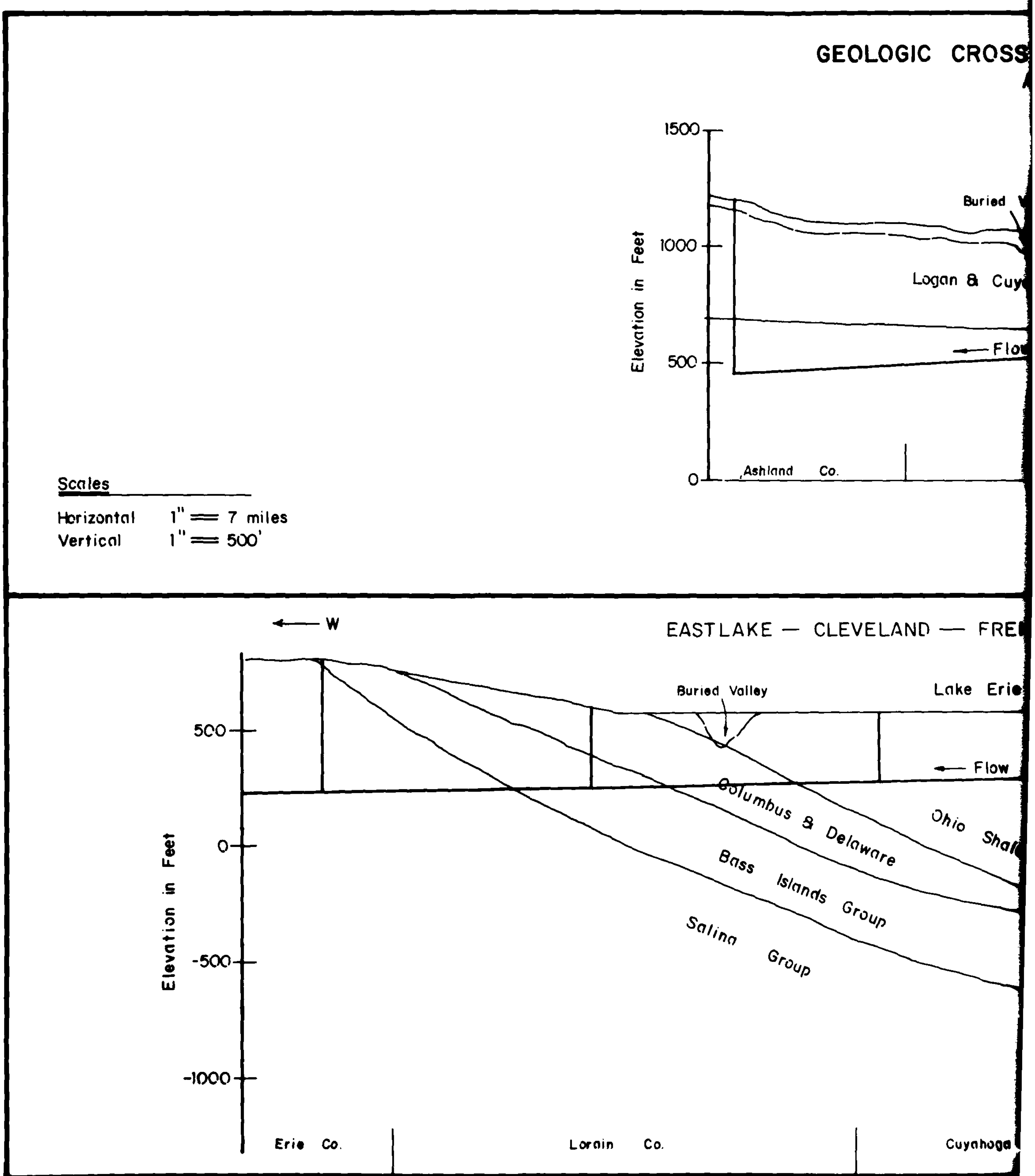
During the initial stages of this study seven potential reservoir sites in the western land treatment area outside the Three-Rivers Watershed were reviewed with respect to bedrock conditions and the impermeability of the overburden of glacial till. The primary distinction that could be made among these sites on the basis of available published information was that some type of lining might be required for reservoirs located farthest to the west over predominantly limestone and dolomite bedrock, whereas sites underlain by shale or sandstone were not expected to require lining, as percolation losses would be minimal.

Subsequently, a single reservoir site at the common corner of Huron, Seneca, and Crawford Counties was selected to provide a centralized location for both winter storage capacity and, if applicable, aerated lagoon treatment. The area is underlain by Ohio shale covered with glacial till, and the reservoir might extend into areas of recessional glacial moraines. There would not appear to be severe percolation problems associated with this centralized reservoir site.

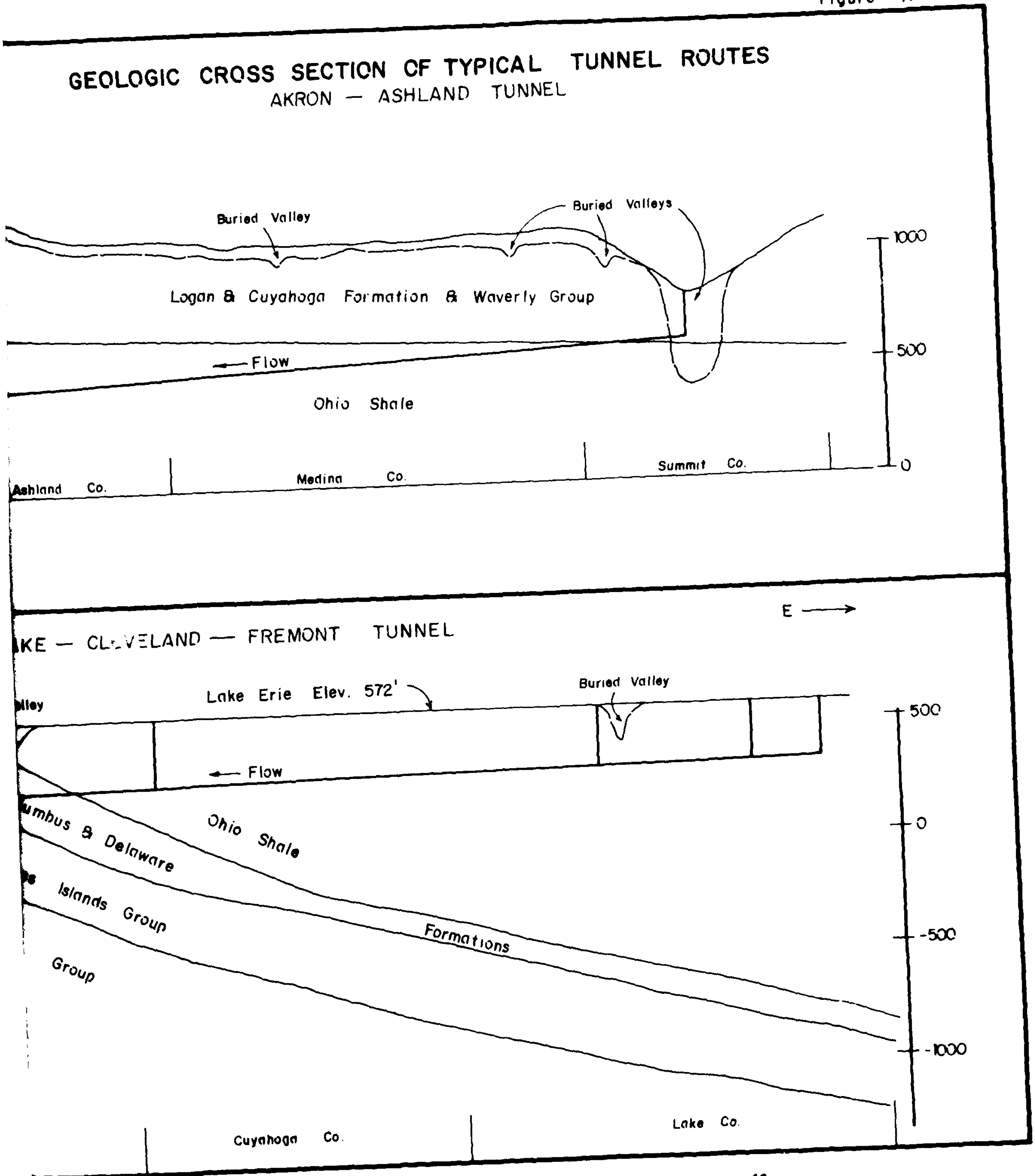
CONCLUSIONS

This preliminary review of the technical literature relating to geologic conditions in northern Ohio supports the conclusion that it would

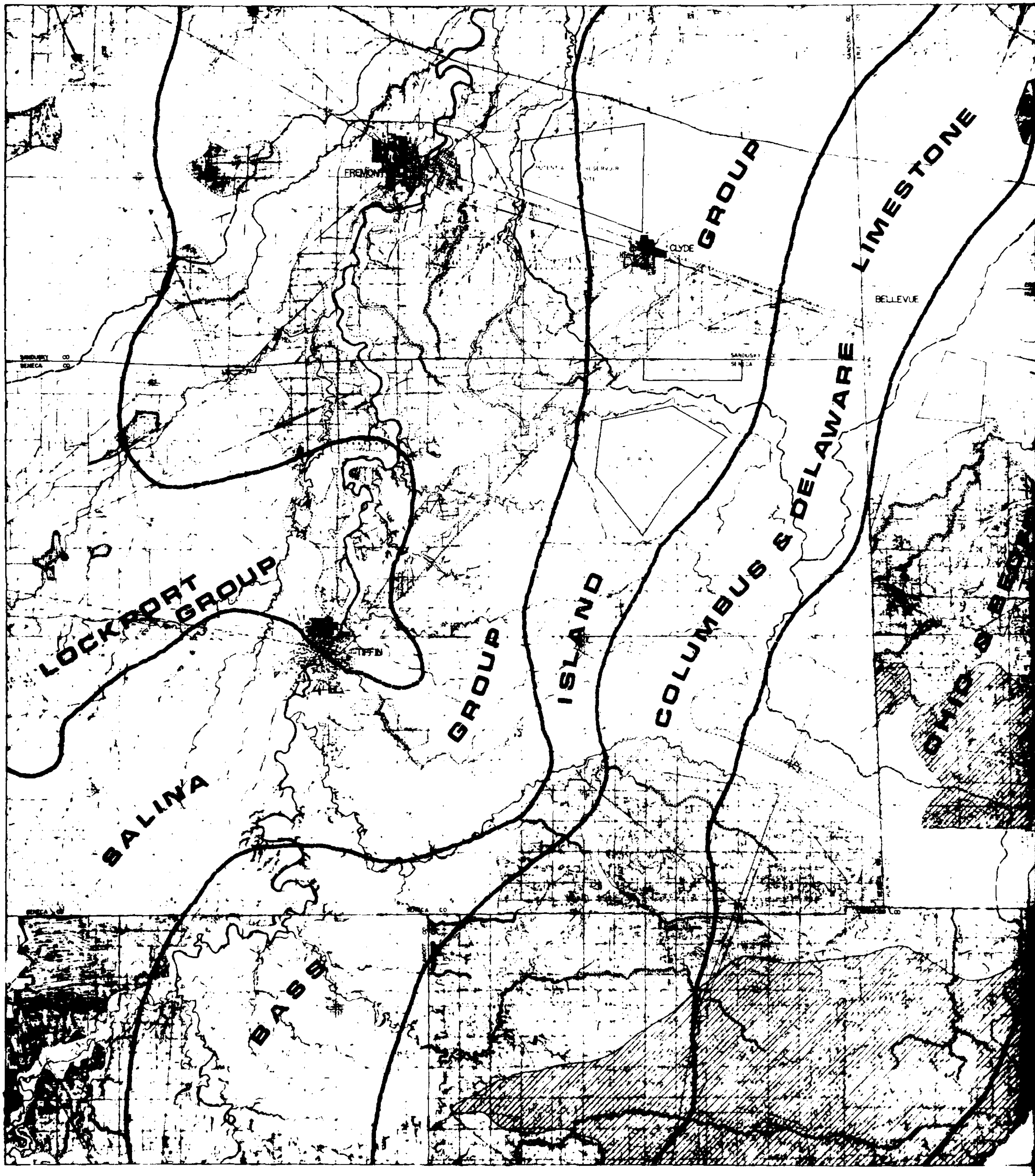
be feasible to construct components of a wastewater treatment system including effluent transmission tunnels, winter storage reservoirs, and land treatment sites in the study area. Tunnels would probably have to be lined through limestone and shale environments, but would require only light supports. Special measures would need to be taken if a tunnel route intercepted a sediment-filled buried valley. Reservoir bottoms would require special type lining if constructed over limestone bedrock. The surface mantle of glacial till would generally be expected to provide good insulation between surface water and bedrock aquifers.

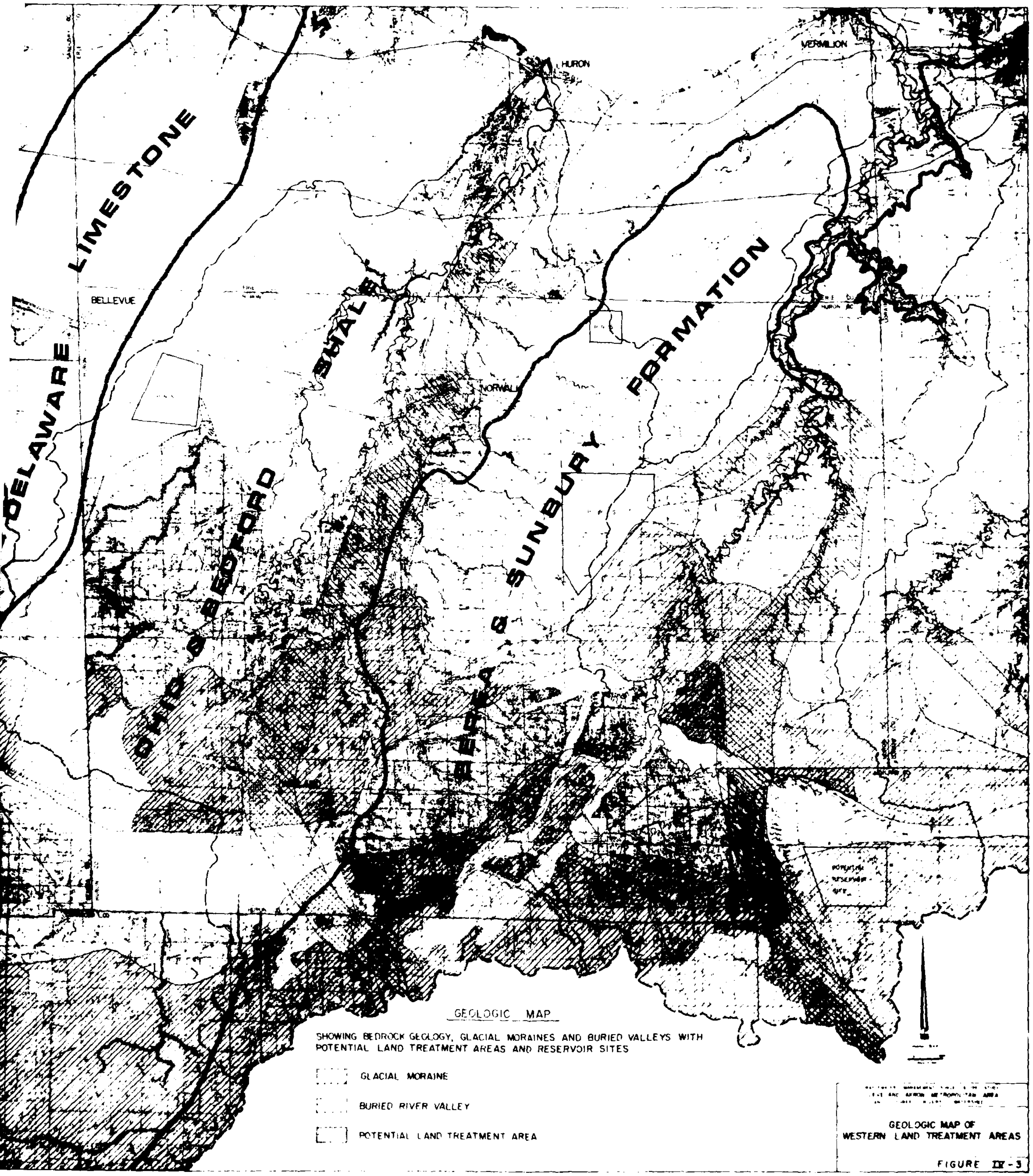


GEOLOGIC CROSS
1500
1000
500
0
Elevation in Feet
Buried
Logan & Cuy
Flo
Ashland Co.
Scales
Horizontal 1" = 7 miles
Vertical 1" = 500'
W
EASTLAKE — CLEVELAND — FRE
Buried Valley
Lake Erie
Flow
500
0
-500
-1000
Elevation in Feet
Columbus & Delaware
Ohio Shal
Bass Islands Group
Salina Group
Erie Co.
Lorain Co.
Cuyahoga


GEOLOGIC CROSS SECTION OF TYPICAL TUNNEL ROUTES
AKRON — ASHLAND TUNNEL
Buried Valley
Buried Valleys
1000
Logan & Cuyahoga Formation & Waverly Group
500
Flow
Ohio Shale
0
Ashland Co.
Medina Co.
Summit Co.
E
KE — CLEVELAND — FREMONT TUNNEL
Lake Erie Elev. 572'
Buried Valley
lley
500
Flow
Ohio Shale
0
mbus & Delaware
Formations
Islands Group
-500
Group
-1000
Cuyahoga Co.
Lake Co.

, 2


FREMONT
CLYDE
BELLEVUE
TIFFIN
LOCKPORT GROUP
SALINA GROUP
BASS ISLAND GROUP
COLUMBUS & DELAWARE LIMESTONE
OHIO & BE
SANDUSKY CO
SENECA CO



GEOLOGIC MAP OF
WESTERN LAND TREATMENT AREAS

FIGURE IV-3

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SECTION V

GROUND WATER HYDROLOGY

Western Land Treatment Area

The ground water aspects of an area considered for land treatment are an important contributing factor to design criteria. Ground water hydraulics, for example, have a significant bearing on the type of drainage system selected. This section of the report deals with the potential western land treatment areas.

The basic data and information used in this ground water section were obtained from the Ohio Department of Natural Resources (Division of Water and Division of Geological Survey), as well as from reports prepared by consulting engineers in the area.

The geology of a given area dictates the aquifers or water-bearing formations which will exist in that area. The geology generally consists of underlying bedrock overlain by unconsolidated material, either or both of which can provide suitable aquifers. The hydrologic properties of these aquifers are basically determined by their porosity and permeability. Porosity is a function of the volume of voids in a given aquifer material, and is determined by such factors as particle size, shape, degree of sorting, compaction, weathering, fractures and solution. Permeability relates to the movement of water through inter-connecting voids within the aquifer material. Thus, formations such as clay may have a high porosity but an extremely low permeability due to their small pore size.

The Western Land Treatment Area lies in the Sandusky, Huron, and Vermilion River Basins, as well as the Pickerel Creek - Pipe Creek area.

This includes most of Seneca and Huron Counties, in addition to northern sections of Wyandot, Crawford, Richland and Ashland Counties, and parts of Sandusky, Erie and Lorain Counties. The proposed land sites for sewage effluent are located in rural sections of this general area where soils have been deemed suitable for irrigation and drainage practices.

For the entire state of Ohio ground water represents about 4.5 percent of the total water use of all users, both private and public.[1] This figure varies from area to area depending on the relative availabilities and qualities of surface and ground waters. Communities in areas underlain by shale bedrock in the Huron River Basin, as well as adjoining basins, derive most of their water supplies from surface sources since wells in the shale bedrock and overlying clayey glacial drift generally produce less than five gallons per minute (gpm).[2, 3, 4, 5, 7] Municipalities in the limestone areas in the western portions of the study region (Sandusky River Basin and Pickerel Creek - Pipe Creek area) generally rely more heavily on ground water resources than do those in the shale areas.[4, 5, 6, 7]

The aquifers in the study area are recharged by precipitation infiltrating through the soil and overburden into the underlying formations. The amount of ground water recharge occurring in each area depends on such factors as the following:

1. Amount, type and distribution of precipitation
2. Soil texture, permeability and depth
3. Depth and permeability of overburden
4. Permeability of bedrock

5. Evapotranspiration
6. Ground water levels and gradients.

In the study area the average precipitation is 34 inches per year and generally increases from north (32 inches per year) to south (37 inches per year) within the area. The portions of the land treatment areas included in Erie, Huron and Lorain Counties are underlain largely by shale bedrock, with varying depths of glacial overburden containing predominantly clay and gravel. Due to the extremely low permeability of the shale and the overlying soils and glacial till, very little precipitation would be expected to recharge the aquifers in this area. Most of the precipitation would be lost through evapotranspiration or through infiltration and overland flow into existing stream channels where it would be carried as surface runoff. The southeastern portion of the study area located in Ashland and Richland Counties contains soils largely of the Cardington-Bennington Association, which were formed in moderately calcareous clay loam till. These soils are moderately to poorly drained, and this, together with the underlying shale bedrock, would indicate that the recharge in this area would be relatively low. Again, a large portion of the precipitation would be lost to evapotranspiration. The southwestern portion of the study area located in Wyandot and Crawford Counties contains relatively poorly drained soil underlain by 50 to 60 feet of glacial till.[4, 5] The bedrock west of Chatfield in Crawford County is limestone while that to the east is predominantly shale.[5] In this general area recharge would probably be very low in the shale bedrock areas and

low in the limestone areas due to the impervious nature of the overlying glacial till. Seneca and Sandusky Counties contain the northwestern land treatment areas. The bedrock underlying the designated land treatment areas in this region is limestone with an overburden of 25 to 50 feet of glacial till containing some sand and gravel layers.[5, 6, 7] The soils are generally sandy and gravelly and are moderately well drained except in southern Seneca County. Generally this area has the greatest ground water recharge potential among the land treatment areas. It should be noted that the area surrounding Bellevue has contaminated ground water as a direct result of the disposal of raw sewage into more than 1600 publicly and privately owned sewage disposal wells. This area will be examined in more detail later in this section.

The major types of aquifers to be considered in the study region are bedrock, glacial, and alluvial or stream deposits. Each of these aquifers will be examined in detail in the following portions of this supplement as they relate to wastewater irrigation.

BEDROCK AQUIFERS

The bedrock geology of the study area can be divided basically into two general sections: limestone in the western section, and shale and sandstone in the eastern section. The contact between these two regions lies along a north-northeasterly line through Chatfield in Crawford County and east of Bellevue in Huron County. (See Geologic Map of Western Land Treatment Areas in Section IV, GEOLOGY.)

The limestone-dolomite or carbonate rock aquifers are by far the most productive in terms of ground water supply in the study area. In northwest Ohio this aquifer system yields 32.7 million gallons per day (mgd) to municipal and industrial wells, as well as large quantities for domestic and agricultural supplies.[8]

Generally, the limestone-dolomite bedrock is overlain by glacial till which increases in thickness from less than 25 feet near Lake Erie to more than 60 in the upper portion of the Sandusky River Basin. Exceptions to the above trends would be buried river valleys which exist to a limited extent in the limestone area. The surface of the limestone bedrock (feet above mean sea level elevation) ranges from a low of 500 feet near Sandusky Bay to a high of about 950 feet in the northwestern portion of Crawford County.[9]

Ground water in limestone-dolomite aquifers moves through a complex system of interconnected openings such as joints, fractures, solution channels, and minor permeable zones. In very few areas involving carbonate bedrock is it possible to predict whether or not the formation will be a suitable aquifer. In areas of thick limestone or dolomite bedrock wells drilled in valley bottoms will generally produce more water than those drilled on valley slopes. This is partially due to the greater amount of water in storage in the valley alluvial fill. Also, solution openings and fractures tend to be more abundant on crests of anticlines and within synclinal troughs than they are on the flanks of folds.

The quality of ground water is directly related to the soluble mineral constituents of the aquifer and of the overlying glacial till

and soil through which recharge water percolates. For the carbonate aquifer, the predominant dissolved constituents are calcium and sulfate which are derived from gypsum, a major impurity of the Silurian and Devonian carbonate rocks. Calcium and sulfate constitute from 50 to 90 percent of the total mineral content in ground water from these carbonate aquifers. Some 20 test wells drilled under the recommendation of the Ohio Water Commission are located in the designated wastewater disposal areas overlying carbonate aquifers. The chemical analyses from these wells showed average concentrations of sulfate and total dissolved solids (TDS) to be 479 ppm and 1061 ppm respectively. These are about double the U. S. Public Health Service recommended limits for sulfate (250 ppm) and TDS (500 ppm). The highest sulfate and TDS concentrations encountered in the study area were in the eastern portion of Sandusky and Seneca Counties and a central sector of Crawford County. The ground water in this region is generally considered brackish and often has TDS, sulfate, and total hardness concentrations greater than 1500 ppm, 800 ppm, and 1000 ppm respectively.[5, 7, 8] Water with a hardness greater than 180 ppm is considered "very hard" and would probably require softening treatment in order to be used for domestic purposes. Generally, drinking water containing greater than the U. S. Public Health Service limits for TDS and sulfate has undesirable taste and laxative properties. The suspected origin of these high levels of TDS, hardness, and sulfate are the gypsum deposits in the carbonate aquifers. Fluoride concentrations generally ranged from 1.0 to 2.0 ppm in the study area. The median iron concentration was 0.8 ppm in the tested wells which is considerably greater than

the USPHS recommended limit of 0.3 ppm. Concentrations of iron in excess of the recommended limit can cause staining. More than 70 percent of the samples analyzed from the region contained varying amounts of hydrogen sulfide.[8] This soluble gas, derived from sulfur-bearing impurities within the carbonate aquifer, produces an undesirable odor of rotten eggs. The ground water in this area contains moderate to very low concentrations of silica, manganese and potassium. Throughout the study area the most prominent water quality problems are the high hardness and sulfate concentrations as well as the occurrence of hydrogen sulfide.

A particular water quality problem within the study area exists near the city of Bellevue. Since the 19th century Bellevue has disposed of its raw sewage and wastes into drilled wells or "sinkholes" in the underlying cavernous limestone aquifer. This practice was continued until a few years ago and has resulted in the contamination, both bacteriologically and chemically, of the entire ground water resources in a five to eight mile wide area extending north of Bellevue to Sandusky Bay and south to Flat Rock. Until the widespread contamination of the ground water near Bellevue, many of the existing water wells in the limestone aquifer produced up to 500 gpm.[10] Homeowners in this contaminated ground water region are now forced to rely on inadequate cistern supplies. During a flood in 1937 many sewage disposal wells overflowed and polluted the surrounding area for several miles. Probably the most serious danger involving the disposal of raw sewage in a limestone aquifer would be the introduction of pathogenic micro-organisms to the ground water system.[11]

Professor Mallman indicates that viruses could be the greatest problem since they can travel extreme distances in the cavernous limestone aquifer. Similar bacteria travel only a few feet in fine-grained material such as soil or sandstone. The most significant chemical pollutant found in this ground water is nitrate. Nitrate concentrations up to 158 ppm with an average of 25 ppm were found in the contaminated area.[10] Nitrate concentrations of greater than 10 ppm (expressed as nitrogen) have been known to cause methemoglobinemia in infants (blue babies).[12] Also, TDS values as high as 1000 ppm were reported in the area, and more recent data seems to indicate that these should be even higher.[7] Undesirable concentrations of ammonia and alkyl benzyl sulfonate (ABS) were also found in the area.

Water levels in the limestone-dolomite aquifer range from 10 to 40 feet below ground level.[8, 13] An area through the eastern portion of Crawford County contains the highest potential well yields in the study area. Recharge through the overlying soils and glacial till is significant in this area. Specific capacities of the wells average about 0.144 gpm per foot of drawdown per foot of penetration (gpm/ft/ft). The maximum projected safe yields for the area range from 500 to 1000 gpm.[8] An area of between one and five miles in width just to the west of this region is characterized by the low permeability of the overburden, thus inhibiting recharge. The specific capacities of test wells in this region averaged 0.028 gpm/ft/ft. The expected well yields for this region are from 150 to 600 gpm. Another area in the western portion of Seneca and Sandusky counties exhibits lower well productions. The specific capacities of the wells in this area averaged 0.0038 gpm/ft/ft, while the projected

safe well yields range from 50 to 200 gpm. The average transmissivity for the entire limestone-dolomite aquifer is between 10,000 to 20,000 gpd per foot.[8]

Much less important in terms of ground water production are the shale and sandstone aquifers in the eastern portion of the study area. Generally wells in the Berea sandstone provide a large portion of the ground water in the Vermilion River Basin, eastern Huron River Basin and a small portion of southeastern Sandusky River Basin. Water levels in the sandstone wells vary from five to 30 feet below ground level depending on pumping rates and recharge in the particular area.[13] The sandstone aquifer is overlain by ten to 50 feet of glacial till, and well yields range from five to 50 gpm with an average of about 20 gpm.[2, 3, 4] The yields are governed by the amount of fracturing of the sandstone and the degree of cementation of the individual sand grains. Shale bedrock underlies the northern portion of the Vermilion River Basin, most of the north and eastern sections of Huron River Basin and portions of southeastern Sandusky River Basin. The shale formations are by far the poorest bedrock aquifers in the study area. Water levels in wells in the shale aquifers generally average between 15 and 40 feet below ground level depending upon the pumping and recharge of the particular area.[13] Wells in the shale bedrock yield little or no water with a maximum of about five gpm.[2, 3] The water quality of the shale and sandstone aquifers could be termed "highly mineralized." The major problems are hardness, iron TDS and hydrogen sulfide. Concentrations generally exceed the USPHS recommended limits and could cause staining problems.

GLACIAL AQUIFERS

A layer of glacial drift varying in thickness from ten to 125 feet covers most of the study area. These deposits are composed largely of clay and silt of lacustrine origin and yield little or no ground water. Glacial moraines in the southern portion of the study area vary in thickness from 50 to 100 feet and frequently contain sand and gravel layers. Wells drilled into these sand and gravel deposits can yield adequate farm and domestic supplies.

The glacial moraines in the Vermilion and Huron River Basins vary in thickness from 75 to 100 feet and contain scattered lenses of sand and gravel interbedded in the glacial till. Wells developed in these areas generally yield five to 25 gpm.[2, 3] Glacial moraines also exist along the eastern sector of the Sandusky River Basin and average over 50 feet in thickness. The majority of the wells drilled in the northern portions of Crawford County are developed in the sand and gravel contained in these moraines and yield from five to 40 gpm.[4, 5] Data is lacking concerning water levels and other aquifer characteristics for glacial aquifers.

Water obtained from the glacial aquifers is generally very hard (300 to 600 ppm) and would require softening treatment for . iestic uses. In a few water samples tested from these glacial ar : t.ıc "or content ranged from 0.53 to 2.1 ppm,[3, 4, 5] which is in excess of the USPHS standards and could cause staining. Total dissolved solids were generally lower than from wells in bedrock aquifers. Concentrations of TDS ranged from 415 to 874 ppm in wells drilled into glacial moraines. The water from these wells was neutral to slightly basic and would cause no corrosion

problems. Generally, the ground water obtained from these shallower glacial wells is of better quality than that from bedrock wells in the study area.

The soils overlying the glacial moraine aquifers are moderately to poorly drained. Recharge to the underlying sand and gravel via percolation through the soil would be minimal. Some recharge is likely to occur from existing influent streams in the area, as well as by seepage from buried stream valleys.

ALLUVIAL OR STREAM DEPOSITS

Buried river valleys extend in a north-south direction in the Vermilion and Huron River Basins, as well as in the northern portion of the study area near Sandusky Bay. A report published as part of the Ohio Water Plan inventory[9] suggests that knowledge is lacking concerning the existence of buried river valleys and that ground water from presently known valleys has only been tapped. Coarser materials (i.e. gravel) provide the most favorable water-bearing conditions in buried valley systems.

A network of buried river valleys about one and one-half miles to two miles in width, which are a vestige of an ancient drainage system, roughly parallel the Vermilion River and its major tributaries. These valleys in the south and central portions of the basin are filled with up to 150 feet of glacial material. The buried river valley in the Huron River Basin extends from north to south through the towns of Milan, Norwalk, Willard and Plymouth. It is covered by more than 100 feet of glacial material consisting of thick layers of clay and till inter-bedded

with less extensive, discontinuous layers of silt, sand and gravel. This valley is from one and one-half to two and one-half miles wide and is also a remnant of an ancient drainage system. A shallow buried valley is present in Sandusky County in the northwestern portion of the study area. This valley generally follows the present course of Green Creek from Green Springs north to Sandusky Bay. The width of the Valley ranges from two to four and one-half miles, and it is filled with up to 100 feet of clay, sand and gravel.

The quality of ground water in these buried river valleys seems to be best in the Huron River Basin. Analyzed water samples from wells in this aquifer range in TDS from 420 to 625 ppm.[2] Iron concentrations (0.4 to 1.9 ppm) are above USPHS recommended limits. Total hardness values (346 to 460 ppm) indicate that softening would probably be necessary, but not to the degree required for bedrock derived ground water. Chemical analysis was available from only one well water sample in the buried river valley aquifer in the Vermilion River Basin.[3] This sample was obtained from an area just west of New London, which is located directly adjacent to a proposed land treatment area. Based on this sample, the water quality of the aquifer seems to be poorer in terms of TDS (1055 ppm). This could be due to soluble mineral deposits (e.g. gypsum) incorporated within the valley fill. There was no water quality information available concerning the Green Creek buried valley.

The hydrologic information relating to the buried river valley aquifers is very meager. Water levels seem to vary from about 20 to 60

feet depending on local use and recharge.[13] The buried valley in the Green Creek area generally yields from five to 20 gpm, depending on the thickness and amount of gravel deposits in the valley fill. Wells developed in the sand and gravel deposits of the buried valley in the Huron River Basin generally yield from 20 to 50 gpm.[6] Productions have been reported exceeding 100 gpm in this valley. The buried valley which parallels the Vermilion River and its tributaries yields 25 to 100 gpm in wells drilled in the southern portion of the basin, while wells in the central section normally yield less than 25 gpm.[3] However, wells yielding more than 100 gpm are known to exist near New London and Savannah. Generally, the water-bearing properties of valley fill material are highly variable in regard to location, and test drilling is helpful in order to locate favorable materials for developing relatively high yields.

The soils overlying these buried river valleys are moderately to poorly drained. The recharge to the buried valley aquifers as a result of soil water percolation would be fairly low in all cases.

RELATIONSHIP OF POTENTIAL LAND TREATMENT AREAS TO THE AQUIFER SYSTEM

The effect of irrigation with treated sewage effluent on water levels or storage in the underlying aquifers will be slight, assuming an adequate drainage system has been designed. The following hydrologic parameters would be affected with the advent of effluent irrigation and sub-drainage in a previously non-irrigated, undrained land area:

1. Infiltration would be somewhat higher due to more vigorous crop cover (and root density).

2. Evapotranspiration would be slightly higher due to transpiration from higher yielding crop cover.

3. Surface runoff would generally be lower because of the artificial drainage system. Farm management and interception of storm runoff from the fields for storage and recycling must be practiced.

4. Total input of water would be increased from 34 inches per year (average rainfall) to a maximum of 94 inches per year (average rainfall plus 60 inches of irrigation with effluent.)

In light of the above-mentioned effects of effluent irrigation, a drainage system designed to remove most of the percolating water moving below the root zone is necessary as far as ground water levels and ground water in storage are concerned. This would be the most desirable case for most of the aquifers in the study area. If the drainage system were "too efficient", ground water levels might gradually decline in the immediate area. In the case of the drainage system not being efficient enough, water levels would rise in the area. One can generalize, however, that unless artificial drainage is adequate enough to remove the water passing the root zone (that not evaporated or transpired), a local water table will rise until hydraulic equilibrium is reached. With a low permeability below the drains, the system must be capable of draining off all percolating water.

Irrigation with secondarily treated sewage effluent should be designed to have a minimal effect on the quality of ground water in the study area. It is assumed that the effluent to be used for irrigation will have undergone adequate chlorination. Remaining pathogenic microorganisms will be removed in the first few feet of percolation in the soil. This is especially true with regard to the soils of the designated

study region, since many of them have high clay and silt contents. All of the suspended or colloidal organic material will be removed in the first foot of soil. Almost all of the organic compounds in solution (with the possible exception of organic phosphate) are removed to a large degree by the soil. Any heavy metals present in the effluent should be removed by the soil to a safe level in water reaching the aquifer. Sulphates and chlorides are expected to pass through the soil zone without being diminshed in total quantity. Nitrate, the mobile form of nitrogen in soils, deserves particular attention since concentrations greater than 10 ppm (expressed as N) have been known to cause methemoglobinemia in infants. Usually, about 70 percent to 85 percent of the nitrogen present in sewage effluent is present in the ammonia form, which is relatively immobile in soils. However, with free oxygen present in the soil environment, ammonium is rapidly transformed microbially to the mobile nitrate form. In this form, nitrate is a potential pollutant of ground water; however, crops have a high nutrient demand for nitrogen and generally prefer the nitrate form to other available forms. Generally, grasses have a greater demand for nitrogen than row crops, due to their greater root density. Thus, with adequate crop cover, there would be virtually no chance of nitrate buildup in the underlying [illegible]und water.

SUMMARY - WESTERN LAND TREATMENT AREAS

[illegible] the leve[illegible] nor the quality of the ground water should be [illegible]ected in most of the designated western land treatment

areas with appropriate design and system management. The quality of most of the existing ground water derived from the area would generally be classed as fair-to-poor, due to high TDS concentrations, as well as hardness, sulfate, hydrogen sulfide, and iron in certain areas. Perched water table conditions could develop in the eastern portion of the study area if drainage were insufficient. This area is underlain by shale and sandstone bedrock, with an overburden of clayey glacial till. The moderately-to-poorly drained soils in this area could contribute to a perched water table without adequate drainage.

A major ground water problem in the Western Land Treatment Area is the contaminated ground water region centered around Bellevue. The present region of pollution extends to one mile east of Clyde and south several miles into Seneca County. This contaminated region underlies about 3,200 acres considered earlier in this study as a potential land treatment site.

Although this site is no longer included in land treatment proposals for wastewaters generated in the Cleveland-Akron vicinity, it illustrates the potential of well-designed land treatment systems as a means of improving a variety of hydrological conditions. A possible response to the ground water setting around Bellevue would be to rule out irrigation, due to the increased flooding risk of contaminated groundwater "backing up" through the system of surface sink holes and fissures in the limestone as occurred in 1937.

An alternative course of action, which would benefit the long-range utility of the aquifer, would be to pump the existing polluted ground water and transport it outside the contaminated region where it could be

used to irrigate crops (grasses). It would be best to use this polluted water for irrigation only at times when cover crops can be grown, in order that nutrient removal would be at a maximum.* While the contaminated ground water was being pumped out of the area, the land overlying the region could be irrigated with treated effluent of a relatively superior quality. Thus, the region would still be available for land treatment. Additional acreage would, however, have to be found outside the study area to use for irrigation with the contaminated ground water. The latter of the two alternatives would have the benefits of gradually improving the existing ground water quality around Bellevue and inhibiting the encroachment of polluted ground water into nearby areas. Also, irrigation with the polluted ground water outside the contaminated area would not jeopardize the ground water quality of the new area if proper precautions were taken regarding land treatment. At present it is known that large springs exist on land and in Lake Erie which are discharge points for the limestone aquifer. It is estimated that perhaps 500 to 1,000 cfs total flow issues from the various springs. Water quality analyses of the various spring waters could not be located; however, in light of the water quality farther south, it is expected that the total limestone aquifer pollution discharge into Lake Erie is significant in terms of TDS.

*The polluted ground water might also be used on land directly over the aquifer for renovation purposes.

SECTION V-A

GROUND WATER HYDROLOGY
Three Rivers Watershed

BEDROCK AQUIFERS

The northern and western portions of Chagrin River Basin are underlain with shale bedrock, an extremely poor aquifer yielding from 0 to 2 gpm in drilled wells.[14] The water quality of this formation is fair, with iron concentration and hardness being the major problems. Iron concentrations average about 1.0 ppm and hardness about 200 to 250 ppm ($CaCO_3$).[14]

Mississippian and Pennsylvanian sandstone and shale provide suitable aquifers for domestic wells in the central portion of the basin (5 to 10 gpm).[14] Pennsylvanian sandstones, known as Sharon conglomerates, are typically found at depths of less than 150 feet below ground surface in the eastern portion of the Chagrin River Basin.

These sandstones yield up to 50 gpm in existing wells. Water levels in these sandstone aquifers range from 30 to 50 feet below ground level[13]. Iron concentration in the ground water ranges from .03 to 1.2 ppm and would require treatment in some cases. Hardness ranges from 100 to 250 ppm in the sandstone aquifer[14].

The upper portion of the Cuyahoga River Basin is largely underlain by sandstone interbedded with some shale. Water well yields in the sandstone formation are about 50 gpm, compared with 5 to 25 gpm in sandstone interbedded with shale[15]. Water levels vary from 25 to 40 feet below ground level.[13] Treatment for iron would be necessary since concentrations range from one to four ppm. Total dissolved solids (TDS) average

about 300 ppm for the sandstone aquifers. Hardness values range from 150 to 300 ppm and would require softening treatment in most cases[15].

In the lower portion of the Cuyahoga River Basin, extending from Akron on either side of the Cuyahoga River north to Lake Erie, lies a shale aquifer. This is a very poor ground water supply, yielding from 0 to 2 gpm in drilled wells. Further east and west of the Cuyahoga River, lie sandstones and shales which will yield up to 25 gpm in water wells[16]. The water quality of these interbedded sandstone and shales is fair to poor. Iron concentrations have been found as high as 18 ppm and would definitely require treatment used as a ground water supply. Hardness averages 250 ppm and would require treatment for domestic uses[16].

Isolated areas of Sharon conglomerate appear in the southern portion of the lower Cuyahoga River Basin. Wells in these areas have water levels ranging from 20 to 30 feet below ground level and yield up to 50 gpm[13]. Iron concentrations are lower (.3 to .7 ppm) than in most aquifers encountered in the Three Rivers Watershed. Hardness ranges from 150 to 500 ppm and would require treatment for most uses. Total dissolved solids are fairly high, ranging from 250 to 650 ppm[16].

The northern portion of the Rocky River Basin near Lake Erie is underlain with shale. Wells drilled in this aquifer generally yield less than 5 gpm[17]. Iron concentrations range from .3 to 6.0 ppm, while hardness ranges from 100 to 600 ppm. Also, extremely high chloride concentrations have been reported in several wells in this shale aquifer[17]. The remainder of the Rocky River Basin is underlain by sandstone interbedded with shale. Yields from existing wells range from 5 to 25 gpm[17].

Water quality in this interbedded sandstone aquifer is fair to poor. Total dissolved solids average about 500 ppm and most of the ground water would require softening treatment. Iron concentrations range from .5 to 1.0 ppm[17]. Scattered areas of sandstone conglomerate exist in the southern portion of the basin and yield up to 50 gpm in drilled wells.

GLACIAL AQUIFERS

A mantle of thick glacial drift, containing sand and gravel lenses, extends over the Chagrin River Basin. Domestic wells producing from 10 to 25 gpm can be obtained by drilling into these lenses in the central portion of the basin[14]. Generally, test hole drilling is necessary to ensure an adequate ground water supply. Water levels in the sand and gravel wells range from 15 to 25 feet in the Chagrin River Basin[13]. Water quality is fair, with hardness averaging about 200 ppm and iron about one ppm. Sulphate concentrations as high as 100 ppm have been noted in gravel aquifers[13]. Most of the shale bedrock of the Chagrin River Basin, as well as the other basins in the Three Rivers Area, is covered by a layer of impermeable clay drift. This is an extremely poor water supply in terms of production.

Sand and gravel deposits within the thick glacial drift occur to a large extent in the southern portion of the Upper Cuyahoga River Basin. Wells drilled in these deposits yield from 5 to 50 gpm[15], with water levels ranging from 20 to 45 feet below ground level[13]. No information was available on water quality from these sand and gravel wells.

The area along the Cuyahoga River in the lower portion of the basin contains sand and gravel deposits within the glacial drift capable of producing 25 to 100 gpm. Other isolated areas of glacial drift containing sand and gravel lenses will produce from 5 to 25 gpm in the lower Cuyahoga River Basin[16].

Glacial moraine deposits in the southern portion of the Rocky River Basin yield from 5 to 25 gpm of fair quality ground water[17]. Total dissolved solids range from 500 to 600 ppm in a limited number of tested samples.

BURIED RIVER VALLEYS

A buried river valley exists along a portion of the Chagrin River in the eastern sector of its basin. Another buried valley lies just west of Chagrin Falls running south into the Cuyahoga River Basin[18]. Wells drilled in these valleys have yields of 25 to 100 gpm[14]. Based on limited information, hardness appears to be 200 ppm and iron concentrations about 1.0 ppm[14].

In the upper portion of the Cuyahoga River Basin, a buried river valley runs southwest of the Town of Burton[18]. The sand and gravel deposits existing in this valley typically yield from 5 to 25 gpm in water wells[15]. A small buried river valley traversing east-west through the Town of Mantua produces similar ground water supplies[18]. Another valley runs from Streetsboro Township south to Brady Lake and yields 25 to 100 gpm in drilled wells[15, 18].

Extending south from Cuyahoga Falls, Akron, Mogadora, and an area

southeast of Akron, is a buried river valley capable of producing 500 to 1,000 gpm in drilled wells[15, 18]. No information is available concerning water quality in these buried river valleys; however, the qualities should be similar to that of the water derived from the sand and gravel aquifers in the nearby glacial drift. Water levels in these buried river valley aquifers vary from 10 to 45 feet below ground level[13].

In the lower and extreme eastern portion of the Cuyahoga River Basin, a buried river valley extends in a north-south direction[18]. It can produce 25 to 100 gpm in drilled wells[16]. A buried valley, capable of producing 500 to 1,000 gpm in water wells, is located in the southern portion of the basin. Also, north of the Town of Hudson, there exist buried valley aquifers, which can produce from 5 to 25 gpm.[16, 18]

In the Rocky River Basin, extending from the southwest corner of Richfield Township in Summit County to Lake Erie at Rocky River, lies an extensive buried river valley capable of producing from 5 to 25 gpm from sand and gravel lenses.[17, 18] Another valley runs in a north-south direction in central Montville and Medina Townships.[18] A small valley also exists in central Lafayette Township.[18] The yields of the above two buried river valleys range from 5 to 25 gpm.[17]

SUMMARY - THREE RIVERS WATERSHED

A comparison of finally-selected land treatment and reservoir sites, with the geographical features discussed above, indicates that ground

water relationships present no constraints, identifiable at this stage of investigation, upon the land treatment proposals within the Three Rivers Watershed area. In general, relatively tight soil conditions and extremely impermeable substrata would retard ground water recharge from the winter storage reservoirs and the artificially drained irrigation sites. Moreover, whatever recharge did result would cause no appreciable deterioration in ground water quality. These conclusions are based upon published soil, geological, and hydrological data available from the Ohio Department of Natural Resources and would, of course, be subject to more detailed engineering field studies prior to final design. In addition, a system of ground and surface water quality monitoring stations would be designed for each treatment site to establish the hydrological impact over time of the land treatment system.

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SECTION VI

SURFACE HYDROLOGY

INTRODUCTION

This section of the report discusses the surface hydrology of the western land treatment areas in the Sandusky, Huron and Vermilion River basins. The hydrologic situation as it exists presently and the impact that land treatment of compatible wastewater and wastes (secondary treated wastewater and stabilized sludge) would have on the surface flow of these streams will be examined. The normal flow conditions and extreme (flood and low flows) flow conditions will be considered.

The streams within the study area all flow north into Lake Erie in north-central Ohio. Certain portions of these drainage basins have been selected as potential land treatment sites for wastewater transported from the Cleveland-Akron metropolitan area. The major uses of surface water within these three stream basins are for power and manufacturing. Lesser uses are for domestic, commercial, irrigation, and rural purposes. The surface water of the Huron and Vermilion Rivers is presently used by humans much more than is the Sandusky River. Domestic water supplies for some of the larger towns, however, depend on the surface water of the Sandusky River. The smaller towns tend to rely on wells for municipal water supply. A greater dependence on surface water as a municipal supply will develop as the area continues to grow and proposed storage reservoirs are actually constructed to improve the flow conditions of the streams.

The Sandusky River was officially designated an Ohio scenic river in

1970 from upper Wyandot County through Fremont, Ohio. This is a special use of the surface water which must be considered with regard to land treatment feasibility in this basin.

CLIMATE

All of the streams in the study area derive their water from precipitation and, therefore, it is important to understand the basic climatic characteristics of the drainage basins.

The average precipitation for the State of Ohio is 37 inches per year and varies from 32" in northwestern Ohio to 44" in southwestern Ohio. Within the study area, the precipitation averages 34" per year and varies from 32" near Lake Erie to 37" near the drainage divide separating the Lake Erie basin from the Ohio River basin. The study area receives less than the average rainfall for the entire state.

Although Lake Erie affects the climate near the shoreline, the main influence is from air masses moving eastward across the great plains. The study area is on the fringe area of storms produced by air masses from the Gulf of Mexico or Canadian sub-Arctic and, therefore, receives less precipitation than other areas of the state.

Six climatic stations in the study area were studied to learn the characteristics of precipitation and snowfall. These stations are listed in Table VI-1.

TABLE VI-1
CLIMATIC STATIONS

Station	County	Elevation in Feet	Years of Record (Prior to 1960)
Fremont	Sandusky	600	60
Sandusky WB City	Erie	606	83
Norwalk Sewage Plant	Huron	684	79
Tiffin	Seneca	760	80
Bucyrus	Crawford	1000	69
Plymouth	Richland	1013	28

The monthly distribution of average precipitation is fairly uniform at these six stations; however, somewhat higher values occur in May, June, and July, with lower values in December and February. The average monthly distribution of precipitation for the six stations is shown in Table VI-2.

TABLE VI-2
PRECIPITATION (INCHES)

	Fremont	Sandusky	Norwalk Sew.	Tiffin	Bucyrus	Plymouth
Jan	2.46	2.40	2.41	2.58	2.88	2.67
Feb	2.01	2.09	1.96	2.16	2.34	2.21
Mar	2.72	2.84	2.79	3.08	3.15	3.05
Apr	3.31	3.15	3.40	3.29	3.18	3.41
May	3.56	3.52	3.74	3.58	3.35	3.80
June	3.96	4.10	4.15	4.19	4.50	4.48
July	3.52	3.53	3.75	3.54	3.22	3.68
Aug	2.98	3.27	3.41	3.18	3.23	3.52
Sep	2.67	2.77	3.07	2.80	2.73	2.76
Oct	2.34	2.05	2.24	2.33	2.40	2.26
Nov	2.30	2.23	2.42	2.53	2.45	2.31
Dec	2.01	2.06	2.01	2.10	2.24	2.11
Annual	33.84	34.01	35.35	35.36	35.67	36.26

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It is evident that precipitation increases slightly in the study area from north to south.

Snowfall contributes to the annual precipitation quantity during the winter months. Most of the snowfall occurs during December, January, February and March, with January receiving the greatest amount. The snowfall does not necessarily accumulate from one month to the next, but often melts off due to a few days of above-freezing temperatures or winter rains. Snowfall depths are shown in Table VI-3 for four climatic stations.

TABLE VI-3
SNOWFALL (INCHES)

	Sandusky	Tiffin	Bucyrus	Plymouth
January	8.3	8.9	8.6	7.2
February	6.6	7.8	7.2	5.9
March	4.5	5.7	4.6	5.4
April	1.2	1.2	1.0	1.0
May	T*	T	0.1	T
June	T	T	0	0
July	0	0	0	0
August	0	0	0	0
September	0	0	0	0
October	T	0.1	0.1	T
November	1.8	2.5	2.5	2.9
December	6.0	7.0	6.9	6.5
Annual	28.4	33.2	31.0	28.9

T* - Trace

The annual snowfall for the study area would be about 30'' per year.

The mean annual temperature for the study area is about 52° F with the highest mean monthly temperature in July of 72° and the lowest mean monthly temperature in January-February of 27° F. The last occurrence of 32° F in the spring is about May 1 and the first occurrence of 32° F in

the fall is about October 10, giving a frost free (32° F) period of about 160 days. The relative humidity is generally about 70-80% throughout the year. Average windspeeds are about 10 miles per hour from the southwest. Lake evaporation is about 31 inches per year with the largest percentage occurring between May and October.

Storms in Ohio generally move from southwest to northeast. The axes of movement for the storms affecting the study area generally are located on or south of the Lake Erie-Ohio River drainage divide. Therefore, the study area is generally off the major storm track for Ohio. However, there have been several major storms in the last 100 years which have deposited in excess of 5-inches of precipitation over large areas within 3-5 days.

The U. S. Weather Bureau has determined rainfall occurrence for the United States (2,3). Rainfall depths for various durations and frequencies are shown in Table VI-4 for the study area.

TABLE VI-4
RAINFALL DEPTH (INCHES)

Duration	Frequency (Years)					
	2	5	10	25	50	100
30 min	1.0	1.2	1.4	1.6	1.8	2.0
1 hr	1.2	1.6	1.8	2.1	2.3	2.6
2 hr	1.4	1.8	2.2	2.4	2.8	3.0
3 hr	1.6	2.0	2.3	2.7	2.9	3.2
6 hr	1.8	2.3	2.8	3.1	3.4	3.8
12 hr	2.2	2.8	3.2	3.5	3.8	4.5
24 hr	2.5	3.2	3.5	4.0	4.5	4.9
2 day	2.9	3.4	4.0	4.6	4.9	5.5
4 day	3.3	4.0	4.6	5.3	5.8	6.5
7 day	3.8	4.5	5.3	6.0	6.6	7.0
10 day	4.3	5.1	5.9	6.6	7.1	7.8

Short duration thunderstorms can provide 0.4 to 0.6 inches of rain in five minutes for the two and ten year storm frequency, respectively. This indicates the desirability of high rainfall detention crops such as grass covering, and the need to provide for detention and treatment of runoff which does occur. Most of the water detained by a grass covering will infiltrate. Summer thunderstorms do occur in the study area; however, most flood-producing storms occur during the winter months. Runoff from these winter storms is aggravated by melting of snow accumulations and by ice jams. Hurricane storms have occurred during the fall in the northeastern part of Ohio; however, none have occurred in the rest of the state.

The occurrence of low rainfall conditions or droughts in the study area is a random event.[9] No trends have been found. Quantities of rainfall during a dry year will vary considerably from station to station.

BASIN CHARACTERISTICS

The Sandusky, Huron, and Vermilion River basins lie in north-central Ohio and face toward Lake Erie and the north. These basins lie about half in the old lake bottom and about half in the till plains. The rivers flowing across this relatively low-relief land have fairly low gradients and are sluggish and meandering. Table VI-5 summarizes some of the physical information about the three major streams and their main tributaries in the study area.

TABLE VI-5
BASIN CHARACTERISTICS (5,6)

Stream	Length (Mi)	Elev. at Source (Ft)	Elev. at Mouth (Ft)	Average Gradient (Ft/Mi)	Drainage Area (sq.mi)
SANDUSKY R.	130.2	1093	573	3.9	1420.0
Green Cr.	22.9	727	574	6.7	80.8
Bark Cr.	10.7	656	575	7.5	12.8
Muskellunge Cr.	18.3	705	576	7.0	46.7
Indian Cr.	7.5	705	633	9.6	11.8
Wolf Cr.	23.9	802	637	6.9	158.0
Honey Cr.	39.3	1005	728	7.1	179.0
Buckeye Cr.	6.0	928	805	20.5	9.2
Sycamore Cr.	20.0	955	745	10.5	64.2
Tymochtee Cr.	54.8	901	757	2.6	302.0
Broken Sword Cr.	32.0	1018	855	5.1	94.7
HURON R.	59.7	1090	573	8.6	406.0
E. Branch	24.0	966	595	15.4	87.8
W. Branch	46.0	1090	595	10.8	262.0
Frink Run	16.1	891	693	12.3	29.8
Slate Run	19.5	950	697	13.0	46.4
VERMILION R.	58.7	1030	573	7.8	268.0
SW Branch	10.4	1115	935	17.3	31.1

The major river basins are wider at the upper or southern end and narrow to their discharge point in Lake Erie. The Sandusky River has a variation of gradients from 25 feet per mile near Tiffin to as low as 2 feet per mile. The basins are underlain by limestone and shale formations, which do not contribute greatly to streamflow. Glacial and lacustrine deposits are thin and impermeable. However, in the upper Sandusky River basin, the drift thickens and is more permeable in areas of moraine deposits. No prominent buried valleys exist (7).

LAND DISPOSAL AREAS

Soils information for the Sandusky, Huron, and Vermilion River basins

has been studied and is described in other sections of this appendix. It was found that suitable soil types for land treatment of wastewater exist within each river basin. The quantity of selected land is shown in Table VI-6 by major river basins and some of their main tributaries.

TABLE VI-6
POTENTIAL LAND TREATMENT AREAS

Basin	Total Basin Area (Acres)	Potential Land Treatment Area (Acres)	(% of Basin)
SANDUSKY R.	910,000	194,340	21.4
Green Cr.	51,700	12,470	24.1
Bark Cr.	8,200	4,080	49.8
Muskellunge Cr.	29,900	2,730	9.1
Indian Cr.	7,560	4,940	65.3
Wolf Cr.	101,200	7,420	7.3
Honey Cr.	114,600	67,500	59.0
Buckeye Cr.	5,900	3,100	52.6
Sycamore Cr.	41,100	32,900	80.1
Tymochtee Cr.	193,500	17,860	9.2
Broken Sword Cr.	60,700	26,700	44.0
HURON R.	260,000	100,250	38.6
East Branch	56,200	12,410	22.1
West Branch	168,000	81,360	48.4
Frink	19,100	10,200	53.4
Slate	29,700	13,440	45.3
VERMILION R.	172,000	33,610	19.6
SW Branch	19,900	14,650	73.7
Vermilion R. above SW Branch	47,800	15,200	31.8

Wastewaters would be applied to these lands at an average rate of 2.3 inches per week during the growing season (average of 68 inches per year), and no application would be made during the winter months, when the effluent would be stored. An application rate of 2.3 inches per week is equivalent to 0.014 cubic feet per second (cfs) per acre or 14

cfs per 1,000 acres. This would be the theoretical maximum rate of return flow due to irrigation from lands with underdrainage and would occur only if irrigation were practiced during periods when the water requirements of the crops were completely satisfied by natural precipitation. During the months of July, August and September, the return flow due to irrigation would generally be less than 90% of the application rate with the balance being consumptively used by the crops.

Irrigation with wastewater would be suspended during storms to minimize overland flow runoff and flood peaks.

Discharge points for the water collected by underdrains are an important consideration so that the physical capacity of the natural drainage channels are not exceeded. Indications of the relative ability of these drainage channels to accept additional water from the irrigated areas will be discussed in the following pages of this section. A detailed determination of drainage channel capacity of smaller and smaller tributaries is not consistent with the present phase of this study. This would require channel cross-section and slope information and may be appropriate at a later time.

NORMAL FLOW CONDITIONS

Within the study area, there are presently 7 gaging stations maintained by the U. S. Geological Survey (11). Most of these stations have operated for a number of years so that average flow conditions can be determined. These 7 stations are listed in Table VI-7 with some of their characteristics. In general, the highest average flows occur during the

the months of March and April, and the lowest flows occur during September and October. The average flow constantly decreases from a peak in March or April to a low in September or October when it begins to increase again. From 40% to 50% of the average annual runoff volume occurs during March and April. For an individual water year, low flows can extend into November and December, and some large winter storms between December and March can cause high peak runoff values and discharge volumes. The stream flow from June to October is generally lower than the average discharge and is less erratic from one year to the next. Summer and fall flows are less variable than winter and spring flows. Flow-duration values for various streams and locations are given in Table VI-8 for the study area (7, 12).

TABLE VI-7

U. S. GEOLOGICAL SURVEY, GAGING STATIONS

Station Name	Tributary Area (Sq. Mi.)	Elevation (Feet)	Period of* Record (Yrs.)	Average* Discharge (cfs)	Maximum* Discharge (cfs)	Minimum* Discharge (cfs)
1. Sandusky R. near Bucyrus	88.8	955	29	81.2	13,500	0.4
2. Sandusky R. near Upper Sand.	298	792	46	235	10,000	0.5
3. Tymochtee Creek	299	786	6	166	6,040	0
4. Sandusky R. near Mexico	774	733	44	558	19,000	1.8
5. Sandusky R. near Fremont	1251	626	44	920	28,000	4.4
6. Huron R. at Milan	371	573	20	283	49,600	2.2
7. Vermilion R. near Vermilion	262	595	20	230	40,800	0

*Value as of 1970 Water Year

TABLE VI-8

FLOW-DURATION(12)

Per Cent of Time Discharge (cfs) Indicated was Equalled or Exceeded

Station	5%	10%	15%	20%	25%	30%	40%	50%	60%	70%	75%	80%	85%	90%	95%
1. Sandusky R. near Bucyrus	350*	170	108	79	59.5	45	27.0	16.8	10.1	6.1	4.8	3.8	3.1	2.4	1.8*
2. Sandusky R. near Upper Sand.	1060	590	375	262	193	146	85.5	49.5	30.0	18.5	14.6	11.4	8.7	6.3	4.0
3. Sandusky R. near Mexico	2800	1450	890	650	450	285	195	117	72	47	38.2	31.3	25.5	20.4	15.2
4. Sandusky R. near Fremont	4600	2450	1480	1000	730	540	360	195	113	70	57	46.5	38	30.5	23.3
5. Huron R. at Milan	1200	600	375	260	193	150	90	55	36	24.6	20.2	16.8	13.7	10.9	8.1
6. Vermilion R. near Vermilion	1110*	565	310	205	144	105	62	36	19.5	10.8	7.6	4.9	3.2	2.0	1.0*

* All values in cfs

The impact of return flow from irrigation with imported wastewater on the normal flow conditions of the streams in the study area will be to increase discharge during the irrigation season. The irrigation season will vary somewhat from year to year, but generally would extend from April to October. For these months, normal streamflows are diminishing from their peak flow in March or April. The relative impact on normal flow conditions is shown in Table VI-9. This table compares the annual average flow, maximum potential wastewater return flow, and the mean annual flood flow. For this phase of the hydrology study, it has been assumed that the mean annual flood (the flood recurring every 2.33 years) represents the approximate maximum channel capacity without overtopping. In actual practice, only a portion of the potential wastewater disposal area would be used. Therefore, the return flow value given is a maximum for each basin listed in Table VI-9. Also, the total annual volume of wastewater to be imported is much less than the sum of the maximum potential return flows for each basin as shown in the table.

Table VI-9 shows that the maximum potential wastewater return flow is never greater than 17% of the mean annual flood, although in many cases the return flow is much larger than the annual average flow. The main conclusion to be drawn from Table VI-9 is that although the stream regime would change due to increased flow, the potential western land treatment areas identified on Figure II-1 are considered to be feasible sites for wastewater disposal from the standpoint of surface hydrology. This conclusion applies to rather large sub-basins within the three

major river basins and smaller drainages will require special study. The distribution of annual runoff and deviations from expected runoff conditions will require further study to optimize wastewater return flow impact on the streams. Erosion and deposition mechanisms will change in the streams and will require definition.

TABLE VI-9
IMPACT OF WASTEWATER TREATMENT (1)
ON STREAMFLOW

Stream	Annual Average Flow (cfs) (3)	Maximum Potential Wastewater Return Flow (cfs) (2)	Mean Annual Flood Flow (4) cfs
SANDUSKY R.			
at mouth	1050	2691	18,000
Green Cr.	64	173	2,800
Bark Cr.	10	56	690
Muskellunge Cr.	37	38	1,900
SANDUSKY R.			
near Fremont	920	2392	15,500
Indian Cr.	10	68	690
Wolf Cr.	120	102	4,000
Honey Cr.	131	932	5,700
Buckeye Cr.	7	43	700
SANDUSKY R.			
near Mexico	558	1139	9,300
Sycamore Cr.	41	460	2,800
Tymochtee Cr.	208	247	3,700
Broken Sword Cr.	61	368	2,500
HURON R.			
at mouth	310	1392	9,800
HURON R.			
at Milan	283	1300	9,000
East Branch	63	173	2,800
West Branch	218	1127	7,100
Frink	30	138	1,550
Slate	45	184	2,300
Unnamed Cr.			
north of Willard	23	161	1,500

(Continued on next page)

TABLE VI-9 CONTINUED

Stream	Annual Average Flow (cfs) (3)	Maximum Potential Wastewater Return Flow (cfs) (2)	Mean Annual Flood Flow (4) cfs
VERMILION R. at mouth	230	460	5,500
SW Branch	30	201	1,850
VERMILION R. above SW Branch	72	213	3,900

(1) See Table VI-6 for drainage basin and sewage disposal area.
(2) Assume 14 cfs per 1000 acres during summer-fall months only. All designated sewage disposal land within sub-basin utilized.
(3) Rough estimate of average flow for some stations determined by correlation with nearby basins.
(4) Mean annual flood determined by reference 14, "Floods in Ohio".

During the winter months, there would be little or no alteration of the natural runoff conditions. Once irrigation was terminated in October, there would be a short-duration decreasing discharge from the land as the groundwater in storage percolated through the soil into the underdrains.

FLOODS

As brought out in the climatic portion of this section, the flood producing storms for the study area generally occur during the winter months and are aggravated by melting of snow accumulations, ice jams, and frozen soil. However, high intensity rainfall does occur during summer thunderstorms. The ten largest floods at the Sandusky River near Fremont are shown in Table VI-10(4).

TABLE VI-10

MAJOR FLOODS

SANDUSKY RIVER NEAR FREMONT

ORDER BY DISCHARGE	DATE	DISCHARGE IN CFS
1	Mar 1913	65,000
2	Apr 2, 1904	41,000
3	Feb 10, 1959	28,000
4	Jan 15, 1930	27,300
5	June 1937	25,700
6	Jan 24, 1959	25,000
7	Feb 15, 1950	22,900
8	Mar 14, 1933	22,600
9	Mar 6-7, 1963	21,500
10	Mar 22, 1927	20,000

The study area has not experienced flood flows per unit of drainage area as great as those which occur in other parts of Ohio. However, major floods have occurred (4). In the 1959 floods, a unit discharge of 150 cfs/sq mi was recorded. Flood damage has occurred in the past in the larger communities of the Sandusky River such as Fremont, Tiffin, Upper Sandusky, and Bucyrus. The flood plains in these towns have been built upon by man.

The flood frequency relationships for six stream locations in the study area are shown in Table VI-11 (13, 14).

TABLE VI-11

FLOOD MAGNITUDE (CFS) AND FREQUENCY

Station	Recurrence Interval (yrs) 2.3	5	10	25	50
1. Sandusky R. near Bucyrus	2800	3800	4800	5800	6900
2. Sandusky R. near Upper Sandusky	4800	6500	7800	9000	11000
3. Sandusky R. near Mexico	9300	12400	14200	17600	20000
4. Sandusky R. near Fremont	15500	20500	24500	29500	33500
5. Huron R. at Milan	9000	12000	14500	18000	20500
6. Vermilion R. near Vermilion	5500	7500	9000	11000	12500

Most damaging floods occur in the study area during the winter when snow accumulations, soil infiltration, and ice jams can aggravate runoff and create large peak flows. Irrigation of wastewater would not occur during the winter months and the surface hydrology of the streams would be affected very little. The only flow contribution that may extend into the winter months would be from draining the land after the irrigation was completed for the season.

Although floods are less likely to occur in summer and fall, there have been floods during these seasons in the past. Operation of the irrigated areas would be such as to minimize the impact on flood producing storms. Irrigation would be terminated when the rainfall was forecasted

or when it occurred. There would be a lag time when continued flow would occur from the previously irrigated land. This flow might tend to aggravate any flooding by increasing the flood peaks (as shown in Table VI-9). An opposing effect on floods is that keeping an area in agricultural use for wastewater disposal by irrigation of crops will be better for minimizing future flood damage than if the area became urbanized. The increased impervious area for urban lands increases runoff considerably. The flood peaks for higher frequency storm would be increased less than 15% due to wastewater return flow.

LOW FLOW

The periods of low flow of Ohio streams represent another extreme flow condition which is of importance. Low flows of streams are important for understanding the water supply potential of a stream without storage, for utilizing the stream, for recreational purposes, for visual amenities, and for diluting sewage as has been the practice in the past. Although rainfall is relatively evenly distributed throughout the year in the study area, droughts do occur and streams become very low or dry up completely for short periods. The study area receives less rainfall on the average than does the rest of the state and, therefore, low flows of streams are especially important. Streamflow records previously discussed illustrated how low flow conditions normally exist in September or October in the study area following the period of maximum evapotranspiration from vegetation.

The base flow in streams is usually sustained by ground water inflow or by return flow of the wastewater effluent from towns. The measure of low flow currently used in Ohio is the flow equalled or exceeded 90% of the time. This measure of low flow will be higher in areas having large permeable glacial deposits (7). The Sandusky River basin, however, has generally thin impermeable glacial drift except in the upper basin (7). The 90% low flow value is shown previously for six stations in the study area in Table VI-8, FLOW-DURATION.

The occurrance of low flow is a random event which must be analyzed and described by statistical techniques. The average 7-day duration low flow discharge having a 2-year frequency is shown in Table VI-12 for six stations in the study area (10).

TABLE VI-12
LOW FLOW (2-YEAR FREQUENCY, 7-DAY DURATION) IN CFS

1.	Sandusky River near Bucyrus	1.80
2.	Sandusky River near Upper Sandusky	4.20
3.	Sandusky River near Mexico	13.5
4.	Sandusky River near Fremont	22.0
5.	Huron River at Milan	10.2
6.	Vermilion River near Vermilion	2.38

In general, low flow conditions are poor in the study area except for Green Creek (Sandusky River tributary) which is fed by springs issuing from the dolomite and limestone (4).

Irrigation of treated wastewater on agricultural lands will definitely improve the low flow conditions of the three major river basins. The return flow will occur during the months of worst low flow conditions and will add to the natural waters. In some water years, the low flow conditions extend into November, December, and January. For these months wastewater irrigation would not help much unless management of the operation provided for storage in "upground" reservoirs.

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SECTION VII

SOIL SELECTION CRITERIA

INTRODUCTION

The investigations of soil, geological, and hydrological conditions summarized in the preceding sections of this Appendix were performed in order to permit an assessment of the physical suitability of areas within the Lake Erie Basin of Ohio for land treatment of secondary sewage effluent. Ideally, the identification of land treatment sites would proceed by screening this inventory of basic data with a comprehensive set of criteria. Any area which failed to satisfy one or more of the physical criteria would be eliminated from further consideration.

In practice, the geological and hydrological conditions in the study area were found to present few major constraints for land treatment. In areas of possible ground water problems, if a site were found to be otherwise suitable, it could be designated a potential treatment site, subject to verification by field studies that subsurface conditions were satisfactory. Land use, proximity to development, and othe- geographic factors also strongly influence land treatment site selection, but they tend to be more susceptible to ready evaluation. The most limiting and significant physical criteria have been found to be those related to soil characteristics, terrain, and land use.

SOILS CRITERIA PHILOSOPHY

The Office of the Chief Engineer of the United States Army Corps of Engineers has issued guidelines for the selection of spray irrigation

land treatment areas, including abbreviated criteria for the more important soil parameters, which may be summarized as follows:

1. Soil textural class: Loam to silt loam surface horizons with similar texture for underlying strata.

2. Surface infiltration rate for soil: Minimum maintained rate of two inches per day, or 0.08 inches per hour.

3. Effective length of travel of effluent within soil: Minimum of six feet* through aerobic, free-draining soil.[1]

These simplified criteria represent an approach to selecting soils which, ideally, would lend themselves to land treatment using normal agricultural land preparation, irrigation (usually spray irrigation), and cropping practices. The paramount requirement for a soil would be hydraulic capacity -- that is, good irrigation and potential drainage characteristics -- qualified by a requirement of adequate removal and storage capacities for wastewater constituents. The former criterion requires moderate to somewhat coarse-textured soils, while the latter adds that such soils need to be fairly deep to ensure adequate renovation of wastewaters.

Other criteria have been developed by agriculturalists and researchers for the "overland runoff" method of land treatment, and for the "rapid infiltration" method. These criteria have been presented in numerous publications related to land treatment, and are summarized in

*This minimum applies to sandier soils having less renovative capacity than the fine grained soils.

the CRREL Report[2], the Washington Report[3], and the Campbell Soup Publication[4].

(There are three conventional methods of applying treated effluent to agricultural lands. These include spray irrigation, overland runoff, and rapid infiltration, which are described as follows: Spray irrigation is the controlled spraying of liquid onto the land, with the flow path being infiltration and percolation within the boundaries of the disposal site. Overland runoff is the controlled discharge, by spraying or other means of liquid onto the land, with the flow path being downslope sheet flow. Rapid infiltration is the controlled discharge, by spreading or other means, of liquid onto the land, at a rate measured in feet per week, with the flow path being high-rate infiltration and percolation[5].)

These other criteria broaden the range of soil characteristics suitable for effluent treatment to include very tight soils, with almost no permeability or infiltration capacity, to extremely coarse soils such as one would find in sand and gravel pit areas. As the type of soil criteria varies from that identified for spray irrigation, the land treatment management and farming practices significantly vary, all as described in the above references.

Logically, with three basic methods of land treatment proposed by the United States Army Corps of Engineers to suit specific types of soils, i. e.:

a) spray irrigation,

b) overland runoff, and

c) rapid infiltration,

it follows that an almost infinite number of variations could be developed to suit soils falling between the coarse and fine-grained soil extremes. By pursuing this logic with agriculturalists and physical scientists/engineers, a selection philosophy was developed which was based on tailoring of unique farm management techniques to best suit specific and unique soils which generally met detailed and somewhat more sophisticated criteria than previously considered.

INITIAL SELECTION CRITERIA

An initial study of northern Ohio soils was made to identify potential land treatment areas on the basis of the initial and more traditional spray irrigation criteria. The results of that survey were recorded in a draft of the Phase I Land Treatment Report completed in June of 1972.[6] Essentially, the findings of that initial survey were that coarse and well-drained soils, although present in significant amounts, are not overly abundant in the study area and have frequently been preempted by urbanization or by use as transportation corridors. A number of these coarser soil areas are, however, well situated to provide treatment opportunities for the wastewaters of nearby small and middle-sized communities, both inside and outside the Three Rivers Watershed Area, such as Burton, Ravenna, Middlefield, Sandusky, and Toledo.

The findings of the initial survey led to a broadened scope of

investigation influenced by the following considerations:

1. The criteria provided by the Office of the Chief Engineer describe soil conditions desirable for spray irrigation land treatment, particularly since they would be quite economical to prepare for land treatment and since modifications in existing crops and farm practices could be minimized. However, tighter soils would be capable of providing higher renovation efficiencies with respect to treatment of secondary effluent.
2. Farm management techniques, including deep plowing, choice of crops, land forming and selective water application methods, offer a powerful tool in adapting land treatment to a variety of soil conditions.
3. The initial soil inventory had identified large, contiguous acreages in the study area of somewhat tighter more finely-textured soils than those meeting the traditional criteria.

Consequently, it was decided to investigate the potential for developing specific management programs suited to the use of particular soils for land treatment. This undertaking was consistent with both the scope of the Land Treatment Contractor's assignment and the Pilot Wastewater Management Program, as a whole, in that its objective was to explore the full range of wastewater management opportunities for the Cleveland-Akron area.

This phase of the land management study did not proceed deductively from a previously-fixed set of criteria for soil characteristics, but rather concurrently with the development of farm management methods and the further study of soil characteristics. Still, it was possible to postulate a new range of values for the soil parameters, which would prove feasible for land treatment. Table VII-1 presents the initial criteria which indicated the general range of soil characteristics that would receive further consideration for spray irrigation and related living filter infiltration methods during this phase of the Land Treatment Study.

This Table VII-1 is not meant to give rigid and fixed limits, but to identify the wide range of soil characteristics which can be considered. The various ranges of characteristics from A through D are not meant to be exclusively identified with either Ranges I, II, or III.

The water table control criteria given in Table VII-1 are intended to differentiate ideal lands from those less so. They assume that if saturation extends to the surface after irrigation, the soil and site conditions would allow drain-out to 36 inches within five days with the drain spacing given.

TABLE VII-1

INITIAL CRITERIA FOR SELECTION OF LANDS FOR IRRIGATION WITH SEWAGE EFFLUENT
LAKE ERIE BASIN OF OHIO

A. Soil Characteristics	Generalized Minimum or Maximum Range of Acceptable Characteristics Related to Effluent Renovation: Range I Ideal Conventional	Range II Acceptable	Range III Acceptable
1. Texture			
Plow Layer	Loam to sandy loam*	Sandy clay loam to silt loam*	Clay to silty clay*
Subsurface	Clay < 40% Silt < 50 Sand > 20	Clay < 60% Silt < 40 Sand > 20	Clay > 60% Silt < 40 Sand < 10
2. Depth			
to barrier	> 60"	> 48"	< 48"
to gravel	> 30"	$18 \leq d \leq 36$	< 18
3. Chemical properties in drainable profile in equilibrium with effluent			
Electrical conductivity, E.C.x10^{-3}	< 2.0	2 to 8	>8
pH	5 to 7.5	3-5 or 7.5-9	< 3 or >9
Exchangeable Sodium Percentage, E.S.P.	< 15	< 15	< 15
Cation Exchange Capacity, C.E.C.	>15 meq/100 gr	7-15	< 7
4. Hydraulic Conductivity of Subsurface, K	$3' \leq K \leq 20''$/day	$2\text{-}3' \leq K \leq 20''$/day	$2\text{-}3' \leq K \leq 20''$/day
5. Infiltration Rate, i	$i > 0.4''$/hr	$0.20 \leq i \leq 0.40''$/hr	$i < 0.2''$/hr
6. Bubbling Pressure, P_b	$P_b < 18''$	$18 \leq P_b \leq 24$	$P_b > 24''$

*Range I (soil characteristics Nos. A-1, 2, 4, and 5). Represents sandy soil with larger hydraulic capacity, the soil often selected for land treatment because of minimal hydraulic constraints, and routine irrigation and drainage management.
Range II (Nos. A-1, 2, 4, and 5). Is moderately tighter soil requiring better land management and closer drain tile spacing
Range III is tight soil where good land management techniques are required, drain tile spacing will be close, and application rates must be more carefully chosen and controlled.

TABLE VII-1
Continued

INITIAL CRITERIA FOR SELECTION OF LANDS FOR IRRIGATION WITH SEWAGE EFFLUENT
LAKE ERIE BASIN OF OHIO

	Generalized Minimum or Maximum Range of Acceptable Characteristics Related to Effluent Renovation		
B. Topography Characteristics	Range I Ideal Conventional	Range II Acceptable	Range III Acceptable
7. Slope	< 2%	$2 \le S \le 15\%$	>15%
8. Surface	Smooth, planar	Slightly hummocky, moderate grading necessary	Hummocky, heavy grading necessary
9. Cover			
Woods	No limitations on density or type.		
Brush	No limitations on density or type. Sprinklers must extend above canopy.		
C. Surface Drainage Characteristics			
1. Outlet	No restriction for surface water disposal	Surface water disposal may require minor ditching	Surface water disposal requires extensive ditching
2. Flooding	Not susceptible to surface backwater.	Surface backwater recurrence interval >10 years.	Surface backwater recurrence <10 yr.
D. Internal Drainage Characteristics			
1. Artificial water table control	Tile drains spaced $\ge$100 ft. will lower w.t. to 36" in five days	Tile drains spaced $40 \le L_s \le 100'$ will lower w.t. to 36" in five days	Tile drains spaced <40' will lower w.t. to 36" in five days
2. Outlet	Gravity outlet immediately available	Gravity outlet requires limited conveyance	Gravity outlet requires extensive conveyance

FINAL SELECTION CRITERIA

The final soil selection criteria was based upon testing the overall soil renovative capacity and character against specific objective and subjective measuring constraints including:

1. Reasonably high and suitably safe hydraulic capacity, as related to specific irrigation application and management methods, of more than 50 inches per year.
2. A high degree of heavy metal removal and storage capacity approaching 100 per cent.
3. Nitrogen removal, with reuse, temporary storage, and atmospheric loss potential without significant leaching, of between 80 and 99 per cent.
4. Phosphorous and calcium removal, with reuse or storage potential without significant leaching, approaching 99 per cent.
5. Suitability for economically reasonable artificial and natural drainage control.

The soil associations which can be utilized for effluent renovation should provide the following properties for each of the designated generalized irrigation management methods, as given in Tables VII-2 through 5.

Specific removal parameters are defined and the estimated performance of specific soils are quantified in Section X of this appendix.

These soil associations constitute a major potential resource for wastewater treatment for the Cleveland-Akron metropolitan area. Investigations into the question of farm management have led to the proposal of several approaches, which appear very promising. Section IX of this appendix presents a discussion and schematic diagrams of some proposed techniques for farm management of land treatment sites.

TABLE VII-2

SOIL PARAMETERS SUITABLE FOR CONVENTIONAL SPRAY IRRIGATION

1.	Texture :	Less than 1/2 silt in A Horizon, or susceptibility to reduction of silt content by plowing. Less than approximately 1/3 clay in A and B Horizons.
2.	Permeability :	Rate of 0.6 inch per hour in A Horizon. Rate of over 3 inches per day in B Horizon.
3.	pH :	Over 4.5, but less than 7.5 in A & B Horizons.
4.	Organic Matter :	At least 2% in A Horizon, or susceptible to buildup with crop residue or sludge.
5.	CEC :	Over 7.5 MEQ/100 GM.
6.	Land Slope :	From 0 to 15%.
7.	Depth to Impermeable Substratum :	No less than 5 feet.
8.	Rock Depth :	Greater than 6 feet.
9.	High Water Table :	Controllable with artificial drainage.

TABLE VII-3

SOIL PARAMETERS SUITABLE FOR
OVERLAND RUNOFF/INFILTRATION IRRIGATION

1.	Texture	: Over 1/3 clay in A Horizon, or B Horizon, or both A and B Horizons.
2.	Permeability	: Rate of 0.2 to 0.6 inch per hour in A Horizon, or B Horizon, or both A and B Horizons.
3.	pH	: Over 4.5.
4.	Organic Matter	: At least 2%, or susceptible to buildup with vegetative residue or sludge.
5.	CEC	: Over 7 MEQ/100 GM.
6.	Land Slope	: Greater than 1/2%, but less than 15%.
7.	Depth to Impermeable Substratum	: No less than 2.5 feet.
8.	Rock Depth	: Greater than 5 feet.
9.	High Water Table	: Controllable with artificial drainage.

TABLE VII-4

SOIL PARAMETERS RELATED TO LOW DROPLET IMPACT IRRIGATION*

1. Texture	:	Over 1/2 silt in A Horizon.
		Less than approximately 1/3 clay in A and B Horizons.
		Over approximately 1/5 sand in A and B Horizons.
2. Permeability	:	Rate of over 0.6 inch per hour in A Horizon.
		Rate of over 3 inches per day in B Horizon.
3. pH	:	Over 4.5, but less than 7.5 in A and B Horizons.
4. Organic Matter	:	At least 2% in A Horizon, or susceptible to buildup with crop residue or sludge.
5. CEC	:	Over 15 MEQ/100 BM.
6. Land Slope	:	Less than approximately 7-1/2%.
7. Depth to Impermeable Substratum	:	No less than approximately 3 feet, and preferably more than 3 feet.
8. Rock Depth	:	Greater than 5 feet.
9. High Water Table	:	Controllable with artificial drainage.

*Refers to spray application through nozzles which produce very fine droplets at relatively high pressure (50 psi). Kinetic energy of these droplets is low. Suitable with low pressure nozzles if grass cover, such as Canary Reed grass, is maintained.

TABLE VII-5

SOIL PARAMETERS SUITABLE FOR OVERLAND RUNOFF IRRIGATION

1.	Texture	: Over 1/3 clay in A Horizon, B Horizon, or both A and B Horizons.
2.	Permeability	: Rate of less than 0.2 inch per hour in A Horizon, or B Horizon, or both A and B Horizons.
3.	pH	: Over 4.5 in A Horizon.
4.	Organic Matter	: At least 2% in A Horizon, or susceptible to buildup with crop residue or sludge.
5.	CEC	: Over 7.5 MEQ/100 GM.
6.	Land Slope	: Greater than 1%, but less than 6%.
7.	Depth to Impermeable Substratum	: No less than 1.5 feet.
8.	Rock Depth	: Not applicable.
9.	Depth to High Water Table	: More than 1 foot, but shallower depths permitted periodically without artificial drainage.

LAND USE CONSTRAINTS

Present and future land use is the most limiting factor affecting the selection of land treatment sites. For instance, some of the best potential soils lie within the City of Akron, but urban development precludes any consideration of this land.

Using the detailed 7½-minute USGS Quadrangle Maps, the extent of urbanization in the twenty-one county area could be estimated. In the western agricultural areas, approximately 75 per cent of the gross acreage might be used for land treatment without imposing on existing development. Minor alterations may be necessary if large pivot machines are used to distribute effluent; for example, it may be necessary to clear some trees and raze some structures.

Within the Three Rivers Watershed, the constraints of urbanization, forests, and vehicular arteries tend to reduce, or make impractical, the use of some of the suitable soils for land treatment. However, smaller tracts of remaining land are often ideally suited for the smaller municipalities. The use of these areas for land treatment would preclude future urbanization, thereby conserving open space.

In the Lake Erie Basin, the major rural areas are currently used for agricultural lands, interspersed with woodland and forests. The forests include oak, hickory, elm, ash, cottonwood, maple, beech, and birch. The composition of the major crops and the livestock in each county is tabulated in Table VII-2. Other crops not listed in this table include those raised by truck farming, fruit, and sugar beets.

In 1965, the average farm size in Ohio was 150 acres; in Northern Ohio, the average farm size was believed to be slightly larger.[7]

The extensive farming enterprises of Northern Ohio show impressive crop yields, as indicated by farm census data for 1970, despite significant drainage handicaps. Whereas less than one per cent of the farm land was irrigated in 1967, over 25 per cent of the land was drained by artificially-created surface or subsurface system.[8,9] Experiments by Ohio State University Cooperative Extension Service have shown that yields can be nearly doubled with tile drainage.[9]

The following drainage problems and needs have been described by the Great Lakes Basin Commission:

1. The "problem lands" are concentrated in northwestern Ohio, in an area of 5.5 million acres (four million of these are in crop and pasture land);

2. One and half million acres of drainage work must be done if the basin is to meet its allocation of the national requirement for food and fibers from this area.[10]

In 1968, some 10,000 acres were irrigated in the general area west of Cleveland. In April, 1971, the Great Lakes Basin Commission pointed out that irrigation would improve the existing form of agriculture and enable farmers to increase their income without competing for additional high value land.[11]

The Commission established gross irrigation requirements for the normal year for the sub-basin lying west of Cleveland, based on 75 per cent irrigation efficiency. While these values are subject to some variation and error, the reported values range from about 24 inches of water

for sod to about 12 inches for corn silage.[11] The amount for vegetables is less.

Commercial fertilizers are commonly used to improve yields and these costs often exceed $30 per acre per year. Many of the soils in Northern Ohio have a low pH. To improve crop yields, lime is often used to increase the pH and, therefore, the availability of most nutrients; to supply calcium and sometimes magnesium; to increase the microbial activity and improve soil structure and tilth.[9]

The following table of 1970 agricultural yields for selected counties is indicative of a significant agricultural economy. Land treatment planning which incorporates and improves upon present land use should be a basic planning objective.

TABLE VII-6

SUMMARY OF AGRICULTURAL PRODUCTS*

Northern Ohio Counties

	Crops - Acres Harvested - 1970					Livestock on Farms 1970 to 1971		
County	Corn for Grain	Soybeans for Beans	Wheat	Oats	All Hay	All Cattle & Calves	Hogs & Pigs	Stock Sheep
Ashland	29,900	5,300	9,900	11,400	30,000	41,800	21,300	9,000
Ashtabula	12,100	1,500	2,800	9,600	30,600	33,000	6,100	1,300
Crawford	48,300	52,400	19,300	9,100	13,000	24,500	59,300	21,300
Cuyahoga	400	500	400	200	1,200	1,000	200	400
Erie	17,400	20,400	9,700	3,800	5,400	9,400	8,100	2,000
Geauga	2,800	--	1,000	3,500	13,700	10,400	1,900	800
Hancock	77,000	96,800	31,600	9,200	11,800	20,600	48,300	16,600
Hardin	68,500	75,600	21,300	11,400	13,600	24,300	60,200	22,900
Huron	46,800	67,800	21,300	10,000	12,200	17,300	29,400	12,300
Lake	1,000	--	600	300	2,000	1,300	400	400
Lorain	18,800	25,100	9,300	6,400	14,300	19,000	9,000	2,900
Medina	16,500	6,100	5,600	7,000	24,100	24,800	8,900	1,900
Ottawa	11,500	41,900	13,600	4,500	13,400	6,400	6,500	1,100
Portage	13,200	--	3,800	6,700	19,000	20,100	4,700	1,200
Richland	25,700	21,500	11,000	9,300	18,100	24,100	23,500	9,700
Sandusky	48,900	56,600	20,200	6,300	11,200	21,200	25,700	6,500
Seneca	57,800	80,000	30,200	11,800	16,400	21,800	44,400	19,500
Stark	29,300	1,200	9,500	11,900	28,000	37,200	17,100	2,000
Summit	1,900	100	1,100	1,400	4,200	3,900	1,000	1,000
Trumbull	11,600	1,500	2,200	6,300	16,100	18,800	2,400	1,000
Wood	96,900	104,500	39,800	16,800	19,400	26,800	26,200	5,900
Wyandot	56,900	62,100	21,200	8,300	9,400	14,900	38,700	21,100
Total	693,200	720,900	285,400	165,200	327,100	422,600	443,300	160,800

*Data taken from Ohio Crop Reporting Service, Ohio Agricultural Statistics, 1971, Columbus, Ohio: Ohio Department of Agriculture, 1972.

OPEN SPACE AND GREENBELT PLANNING

In the Three Rivers Basin, about 25 per cent of the land is urbanized. If present trends continue, there will be little open space left in the year 2020.

Land treatment provides an opportunity to establish open space, greenbelts, and related refuge for wildlife, thus pre-empting unplanned urban sprawl. Large areas could be set aside for the future, used in the meantime, and incorporated into land treatment sites during the next century.

Toward this end, selection of lands may be oriented to urbanized regions. The reader is referred to a publication entitled Where Not to Build; A Guide to Open Space Planning, Tech. Bulletin No. 1, Bureau of Land Management, U. S. Department of the Interior, Washington, D. C. for specific planning discussions on holding lands open for present and future use.

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SECTION VIII

SELECTION OF OPTIMUM LANDS

The selection of the optimum lands for further consideration for use in the Cleveland-Akron-Three Rivers Wastewater Management Study was a process which resulted in the final selection of three basic soil associations listed below:

1. Mahoning-Ellsworth
2. Cardington-Bennington
3. Chili

Many additional soil associations could continue to receive consideration in future work; however, the three selected appear to be the most suitable at this time.

The total area of the soil associations presented in Table II-1 amounts to 1,661,700 acres, or approximately 2,600 square miles. Depending upon the method of irrigation or renovation, other land areas might also have been included. Some of the soils overlying limestone rock might be ideally suited for renovation purposes, since drainage tile might not be required, especially if the soil mantle above the limestone were reasonably fine-textured and had a thickness of 40 to 50 inches. The soils which might fall into this category are located in eastern Sandusky and Seneca Counties. Water renovated by the soil mantle would be available by pumping from wells.

The acreages shown in Table II-1 for each association denote the total gross areas for these soils. In developing the optimal land treatment plans for the Cleveland-Akron-Metropolitan and Three Rivers

Watershed area, final land selection was made, based on carefully considered parameters such as preferred soil characteristics, site location, site configuration, and land use.

Soils for Conventional Spray Irrigation

The soils suitable for conventional spray irrigation, some requiring a manipulation of the A Horizon silt content, include:

a. Chili
b. Wooster
c. Chenango-Red Hook
d. Colonie-Elnora
e. Otisville-Chenango
f. Digby-Haney-Millgrove
g. Painesville
h. Sisson-Tuscola
i. Arkport-Galen
j. Belmore-Digby-Seward-Ottokee
k. Berrien
l. Bogart
m. Olena
n. Wilmer
o. Haskins-Jimtown
p. Chili-Wheeling
q. Belmore-Haney
r. Oakville
s. Wauseon
t. Canfield
u. Granby
v. Rimer

Other soils, including Bennington and Cardington and related series, are suitable if the A Horizon silt problem can be overcome by selected crops, application techniques, or surface preparation.

TABLE VIII-1

SOIL PARAMETERS
CHILI SOIL SERIES

Parameter	Soil Horizon			General
Depth (inches)	0-12	12-26	26-60	
Texture USDA	Silt Loam	Gravelly Loam	Gravelly Sandy Loam	
Per Cent Sand	23.6	21.8	64.3	
Per Cent Silt	60.5	58.0	18.0	
Per Cent Clay	15.4	20.2	17.7	
Permeability (Inches per hour)	2.0-6.3	2.0-6.3	>12.0	
Available Soil Moisture (Per Cent)	0.10-0.18	0.10-0.14	0.02-0.04	
pH	4.5-5.5	4.5-5.5	5.6-6.5	
Organic Matter (Per Cent)	2.2	0.4	0.1	
C.E.C. (meq/100gm)	14.0	12.8	8.9	
Land Slope (Per Cent)				1-15
Substratum				
Depth (feet)				3.5
Material				Gravel & Sand with fines
Rock Depth (feet)				>5
Seasonal High Water Table (feet)				3+

Soils for Overland Runoff/Infiltration Irrigation

The soils best suited for the combination overland flow-infiltration method of land treatment are fine-textured in the A Horizon so that water will not readily infiltrate, but will tend to flow over the surface for long distances as in the overland runoff method. On the other hand, the infiltration and permeability rates need to be within ranges which will permit the overland flow to finally infiltrate into, and through, the living filter.

Comparing soils in Table II-1 against criteria in Table VII-3, one finds that the Mahoning-Ellsworth Soil Association is suitable, provided that subsurface drainage can be maintained with tile drains. Otherwise, this soil association would be limited to the overland runoff method.

The Mahoning-Ellsworth-Trumbull Association is listed in Table II-1, and shown on Figure II-1, as Map No. 27. The association is listed variously as Mahoning-Ellsworth-Trumbull, Mahoning-Ellsworth, and, in one case, as Mahoning-Bogart, Haskins-Jimtown to correspond to the names given in each County on the General Soils Maps. The latter soil is made up predominantly of the Mahoning series, interspersed with the Bogart, Haskins, Jimtown, and minor amounts of other soils.

The Mahoning-Ellsworth-Trumbull Association is the dominant soil association within the basin; it also occurs extensively in Lorain and Huron Counties to the west. For conventional crops and irrigation, these soils are not permeable enough to allow for high application rates.* Because of its low permeability, however, the overland flow/infiltration

*High application rates generally imply four inches per week or more, but for Mahoning soils, a high application rate would be 60 inches/year.

technique (called the mini-border/open space method) was developed. The Mahoning and Ellsworth soil parameters are presented in Table Nos. VIII-2 and VIII-3.

TABLE VIII-2

SOIL PARAMETERS
MAHONING SOIL SERIES

Parameter	Soil Horizon			General
Depth (inches)	0-11	11-32	32-74	
Texture USDA	Silt Loam	Silty Clay Loam	Silty Clay Loam	
% Sand	18.6	16.1	17.7	
% Silt	44.2	38.9	42.1	
% Clay	37.2	45.0	40.2	
Permeability (in./hr.)	0.2-0.63	0.063-0.2	<0.063	
Available Soil Moist. (%)	0.19-0.23	0.15-0.18	0.15-0.18	
pH	4.5-5.5	4.5-5.5	7.1-8.0	
Organic Matter (%)	0.7-2.6	0.4	0	
C.E.C. (meq/100gm)	14.7	21.0	20.6	
Land Slope (%)				1-4
Substratum				
Depth (ft.)				3.0
Material				Clay loam or silty clay loam till
Rock Depth (ft.)				>5
Seasonal High Water Table (ft.)				½-1½

TABLE VIII-3

SOIL PARAMETERS
ELLSWORTH SOIL SERIES

Parameter	Soil Horizon			General
Depth (inches)	0-8	8-37	37-60	
Texture USDA	Silt Loam	Silty Clay Loam	Silty Clay Loam	
% Sand	19.4	18.4	22.0	
% Silt	60.4	53.0	44.9	
% Clay	20.2	38.6	33.1	
Permeability (in./hr.)	0.63-2.0	0.063-0.2	0.063-0.2	
Avail. Soil Moist. (%)	0.18-0.22	0.16-0.19	0.16-0.19	
pH	4.5-5.0	4.5-6.5	7.1-8.0	
Organic Matter (%)	1.6	0.5	0	
C.E.C. (meq/100gm)	13.0	18.3	16.6	
Land Slope (%)				4
Substratum				
Depth (ft.)				2.5
Material				Clay loam or silty clay loam till
Rock Depth (ft.)				>5
Seasonal High Water Table (ft.)				$1\frac{1}{2}$-3

Soils for Low Droplet Impact Irrigation

The soil series in Northern Ohio which have high silt content, a pH above 5, a high C.E.C., and good hydraulic capacity with proper artificial drainage (over 4.8 inches per day) are the Cardington-Bennington and related soil series.

The soil associations, earlier identified by Map Numbers 1A and 5, have been combined and termed the Cardington-Bennington Association, even though this association is also identified as the Cardington-Bennington-Pewamo in Seneca County and Cardington-Bennington-Lobdell in Crawford County. The differences between these soils are slight, and for the purposes of this Report, can be grouped into one association that is dominated by the two soil series, Cardington and Bennington.

The Cardington-Bennington Association occurs extensively in Huron, Seneca, and Crawford Counties just west of the Mahoning-Ellsworth-Trumbull Association. The permeability of this soil is greater than that of the Mahoning soil and it is believed that a viable agriculture can be maintained with application rates higher than 75 inches per year, provided management techniques for water application are employed.

A fine-textured soil, such as the Cardington-Bennington soil has the advantages of large absorption capacities. The main concern will be to ensure against extended anaerobic periods in the root zone.

Soil parameters are tabulated on Tables VIII-4 and VIII-5. The content requires low impact droplet control on bare surfaces, achievable with solid set sprinklers.

TABLE VIII-4

SOIL PARAMETERS
CARDINGTON SOIL SERIES

Parameter	Soil Horizon				General
Depth (inches)	0- 8	8-18	18-30	30-60	
Texture USDA	Silt Loam	Silty Clay Loam	Silty Clay Loam	Clay Loam	
% Sand	24.3	19.1	23.4	24.2	
% Silt	57.0	48.6	48.9	51.6	
% Clay	18.7	32.3	27.7	24.2	
Permeability (in./hr.)	0.63-2.0	0.2-0.63	0.2-0.63	0.2-0.63	
Avail. Soil Moist. (%)	0.18-0.23	0.19-0.21	0.18-0.19	0.16-0.18	
pH	5.1-6.0	5.1-6.0			
Organic Matter (%)					
C.E.C. (meq/100gm)					
Land Slope (%)					0-6
Substratum					
Depth (ft.)					2.5
Material					Clay loam till
Rock Depth (ft.)					> 5
Seasonal High Water Table (ft.)					$1\frac{1}{2}$-3

TABLE VIII-5

SOIL PARAMETERS
BENNINGTON SOIL SERIES

Parameter	Soil Horizon				General
Depth (inches)	0-6	6-12	12-32	32-60	
Texture USDA	Silt Loam, Loam	Silty Clay Loam	Clay Loam	Silty Clay Loam	
% Sand	20.3	20.7	27.4	19.8	
% Silt	62.2	53.9	41.1	49.9	
% Clay	17.5	25.4	31.5	30.3	
Permeability (in./hr.)	0.63-2.0	0.2-0.63	0.2-0.63	0.2-0.63	
Avail. Soil Moist. (%)	0.16-0.20	0.15-0.18	0.15-0.18	0.15-0.18	
pH	5.0-6.0	5.0-6.0	5.1-7.3	7.1-8.0	
Organic Matter (%)	2.6	0.6	0.5		
C.E.C. (meq/100gm)	15.2	15.9	22.5	14.8	
Land Slope (%)					0-6
Substratum					
Depth (ft.)					2.7
Material					Clay loam till
Rock Depth (ft.)					>5
Seasonal High Water Table (ft.)					$\frac{1}{2}$-$1\frac{1}{2}$

Soils for Overland Runoff Irrigation

Even though the overland runoff was discovered in Ohio by the Campbell Soup Company[1], most of the soils in Northern Ohio tend to be somewhat too permeable for the established criteria as set forth in Table VII-5. However, the Ravenna Arsenal fragipan lands appear to be suitable, and it is believed that the Mahoning-Ellsworth could be used for the overland runoff method.

Area of Soils Available

To be economically feasible, the soil types selected for land treatment must occur in area magnitudes reasonably related to requirements.

The tabulated areas of each of the identified soil associations are presented below, without regard to present urbanization or development.

TABLE VIII-6

SOIL ASSOCIATION - IRRIGATION METHODS

Soil Association	County	Area in Acres
CONVENTIONAL SPRAY IRRIGATION		
Chenango-Red Hook	Ashtabula	35,500
Colonie-Elnora	Ashtabula	
Otisville-Chenango	Ashtabula	
Chili	Cuyahoga	28,400
Painesville	Cuyahoga	
Sisson-Tuscola	Erie	19,800
Arkport-Galen	Erie	
Chili	Geauga	13,100
Belmore-Digby-Seward-Ottokee	Hancock	21,800
Berrien	Hancock	
Bogart	Hancock	
Chili	Hancock	
Olena	Hancock	
Painesville	Hancock	
Wilmer	Hancock	
Wooster	Huron	19,200
Chili	Huron	
Chili-Colonie	Huron	
Berrien	Lake	32,200
Haskins-Jimtown	Lorain	36,400
Chili-Wheeling	Partage	32,900
Belmore-Haney	Richland	2,000
Oakville-Belmore-Haney	Richland	
Wauseon-Digby-Millgrove	Sandusky	55,700
Haskins-Haney-Belmore	Seneca	41,800
Canfield-Wooster	Seneca	
Chili	Summit	50,100

TABLE VIII-6
continued

Soil Association	County	Area in Acres
Canfield	Trumbull	3,400
Ottokee-Granby-Seward	Trumbull	
Rimer-Wauseon	Wood	70,000
Henshaw-Uniontown-Patton	Wyandot	30,700
SUB-TOTAL		493,000
OVERLAND RUNOFF/INFILTRATION IRRIGATION		
Mahoning-Ellsworth	Ashland	5,600
Mahoning-Ellsworth-Trumbull	Cuyahoga	179,000
Mahoning-Bogart-Haskin-Jimtown	Erie	29,000
Mahoning-Ellsworth	Geauga	43,900
Mahoning-Ellsworth-Trumbull	Huron	111,200
Mahoning-Ellsworth-Trumbull	Lake	64,300
Mahoning-Ellsworth-Trumbull	Lorain	136,900
Mahoning-Ellsworth-Trumbull	Medina	114,600
Mahoning-Ellsworth	Portage	30,200
Mahoning-Ellsworth	Summit	46,100
Mahoning-Ellsworth-Trumbull	Trumbull	44,800
SUB-TOTAL		805,600
LOW DROPLET IMPACT IRRIGATION		
Cardington-Bennington	Ashland	9,800

TABLE VIII-6
continued

Soil Association	County	Area in Acres
Cardington-Lobdell-Bennington	Crawford	203,700
Bennington-Cardington	Huron	79,200
Bennington-Cardington	Richland	17,500
Bennington-Cardington-Pewamo	Seneca	52,900
SUB-TOTAL		363,100
TOTAL		1,661,700

GENERAL

The selection of optimum lands for treatment of wastewater effluent for the Three Rivers Basin demonstrates that a wide variety of lands are available without going to the tested and proven extremes of "rapid infiltration" and "overland runoff".

For the soils selected, land treatment of wastewater effluent would generally involve application rates varying from 26 inches per year by spray irrigation on golf courses to 90 inches using the overland flow/infiltration method.* Using the latter method for separate stormwater runoff, a rate of 150 inches per year may be used. It is believed that field testing in early action projects will demonstrate that higher rates can be used successfully with high renovation of wastewater. The actual application rate would depend on the method of application, the crops grown, and the soil characteristics. The average April-September precipitation is generally adequate for most crops and soils, except for the droughty soils. In a wet year, adequate drainage is more of a concern than lack of optimum soil conditions. However, during a dry year (with a recurrence interval of ten years), as much as 15 inches of supplemental moisture would be welcomed by the farmers. On the average, it can be assumed that 90 per cent or more of the water applied will be surplus to crop needs. Under these conditions, sub-surface tile drainage is essential to maintain a well-aerated root zone, unless the topography and geology allow alternatives, such as pumping for reuse out of an aquifer underlying the land treatment area.

*See Section IX.

Although the texture of the soil cannot be changed, the layers can be economically altered* by deep plowing.[2] The soil can either be turned on edge or turned over with a mould-board plow, depending on the desired results. For example, the Chili soils have an upper "A" horizon with a high silt content and a "C" horizon of sandy soil two feet below the surface. Although the upper layer is very permeable (2.0 to 6.3 inches per hour), the high silt content may cause the soil to lose its structure when wet. The soil may puddle under sprinkler irrigation, and the infiltration rate may be substantially reduced. When the soil dries, a thin surface crust forms, further reducing the infiltration rate. By plowing three feet deep, the Chili soil horizons can be essentially reversed, with some mixing occurring. The resultant soil will be suitable for sprinkler irrigation and still have the renovating capacity desired.

Maintaining a ground cover of grass or hay would be an alternative solution for keeping surface infiltration rates at a higher level. On the other hand, soils with a clay bulge in the "B" horizon become increasingly impervious as one proceeds downward. Placing these soil layers on edge will increase the vertical permeability significantly.

The permeabilities of the various soils listed in Table II-1 cover a wide range. The range of permeabilities for the three soil associations selected are listed below:

*Deep plowing has been found to be "economical" when it rehabilitates otherwise unproductive soil, or improves soil for continued use. Plowing costs are in the order of $20 to $40 per acre.

Soil Association	36-inch Permeability Range (in/hr)
Mahoning-Ellsworth-Trumbull	0.063 to 0.63
Cardington-Bennington	0.2 to 2.0
Chili	2.0 to >12.0

Related field work and investigation, including soil borings and inspection of soils and fields in the Threee Rivers Basin and in Huron County, developed techniques of Farm Management specifically aimed at land treatment. These techniques included:

1. The Mini-Border Open Space System for rough grass/ winter cattle feed.
2. The Center-Pivot Drip Tube System for corn.
3. The Solid Set Sprinkler for hay and pasture.
4. The Alfalfa Border System for field storm runoff storage and infiltration.
5. Center Pivot Rig -- Flood Jet/Grass Strip
6. Center Pivot Rig -- Reed Canary Grass
7. Center Pivot Rig -- Slip Plow/Drip Tube
8. Center Pivot Rig -- Two Row Corn Strips
9. Center Pivot Rig -- ABC Method (Alternating Biennial Cropping Method)

Analyses indicated that these techniques were probably superior to the conventional spray irrigation methods using sandier soil, because of the superior renovative capabilities of the fine-grained soils.

Most significantly, it became evident that a wide variety of irrigation and drainage techniques could be employed on difficult soils.

The farm management techniques pointed towards dropping the sandier soils from further consideration. Thus, sandy Seneca and Sandusky County lands were bypassed in favor of the tighter Cardington-Bennington. The Chili soils were retained because of the proximity to small urban areas in the Upper Cuyahoga River Basin.

The irrigation techniques developed for the Mahoning-Ellsworth and the Cardington-Bennington soils are expected to vary from those chosen as additional testing and development takes place to optimize the procedures. In addition, consideration may be given to the Mahoning soils lying west of the Rocky River Basin, which would greatly reduce tunnel costs from the Cleveland lake front.

The three soil associations selected are listed below, with application rates related to cropping and renovative capability.

Association	Effluent	Application Rate	Crop*
1. Chili	M&I	60 in/yr	General
2. Mahoning-Ellsworth	M&I	90 in/yr	Grass
	Storm Runoff	150 in/yr	Grass
3. Cardington-Bennington	M&I	75 in/yr	Corn or Grass
	M&I	50 in/yr	Hay
	M&I	90 in/yr	Grass

*Research and development should be aimed at studying cultivation of crops such as onions, radishes, carrots, soy beans, and sugar beets, as well.

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2. Telephone call from Ralph Toren, Wright-McLaughlin Engineers, to R. R. Cairns, Officer-in-Charge, Research Branch, Solonetzic Soil Substation, Canada Department of Atriculture in Vegreville, Alberta, on October 27, 1972. (Mr. Cairns stated that deep plowing (56 c.m.) could be accomplished for $10 to $15 per acre, using equipment already in common use on most farms.)

3. Melbourne and Metropolitan Board of Works, Melbourne and Metropolitan Board of Works Farm. Melbourne, Australia, 1971.

4. Parizek, R. R., and others. "Waste Water Renovation and Conservation". The Pennsylvania State University Studies No. 23, University Park, Pennsylvania: The Pennslyvania State University, 1967.

5. Wilson, C. W. and F. F. Beckett (eds.) Municipal Sewage Effluent for Irrigation. (Papers presented at the Louisiana Polytechnic Institute, July 30, 1968) Ruston, Louisiana: The Louisiana Tech Alumni Foundation, 1968.

SECTION IX

FARM MANAGEMENT OF LAND TREATMENT SITES

The success of land treatment areas for productive farming and ranching operations, coupled with efficient renovation of treated sewage effluent into good quality water, is dependent upon careful planning and proper farm management. The basis of this planning must include consideration of the right surface form, water application technique, soil preparation, and drainage system; this is the domain of the agricultural engineer. For example, soils with high silt content in the upper horizon might normally be suitable for treatment with limited amounts of effluent; however, given proper site preparation and irrigation techniques designed to optimize use of the soil in question, the land could be treated with 50 to 150 inches of water per year.

Tight, fine-grained soils have the greatest potential, if managed properly, for a high degree of sewage effluent renovation by land treatment. Sandier soils, with high permeability, suitable for conventional spray irrigation, might be selected when finer-grained soils are not readily available near a metropolitan area, or if farming operations and traditional practices tend to prevail. In Northern Ohio, both the sandy and the fine-grained soils are found.

The Lake Erie Basin of Northern Ohio has large areas of fine-textured soils, such as the Mahoning, Ellsworth, Cardington, and Bennington. The Upper Cuyahoga River Basin also has Chili soils underlain with permeable gravels. In Sandusky and Seneca Counties, the

permeable soil associations exist in large areas between Tiffin and Fremont, amounting to about 90,000 acres. Except for the Chili soils, the lighter and coarse-grained soils have generally been bypassed in the final selection process for those soils with a greater effluent renovation capability.

The reader is referred to Tables VIII-1, VIII-2, VIII-3, VIII-4, and VIII-5 for a summary of soil characteristics applicable to this study, and soils chosen for land treatment purposes for the Cleveland, Akron, Three Rivers Basin wastewater management study.

SOIL PROPERTIES

The soil properties of the five primary soils selected for land treatment purposes are briefly described below.

Mahoning. This soil is a silt to silty clay loam with a high percentage of silt and clay. The natural permeability decreases rapidly below one foot of depth, and the pH is quite acid. The cation exchange capacity is high. Land slope is generally from one to four per cent. The substratum begins at about three feet and is clay loam or silty clay loam till. Bedrock is greater than five feet deep. The wastewater renovative capacity is excellent.

Ellsworth. The similarity with Mahoning soils is quite close, though the Ellsworth is somewhat more permeable near the surface and at depth. The renovative capacity of the Ellsworth soil is excellent.

Chili. The Chili soils series in the Upper Cuyahoga Basin ranges from

silt loam to gravelly sandy loam, with a high silt content in the A Horizon. The natural permeability is high near the surface, and increases with depth. The pH indicates an acidic soil, and the cation exchange capacity is high. Land slope is quite variable, ranging from one to fifteen per cent. The substratum begins at about three and one-half feet and consists of gravel and sand. Bedrock is below five-foot depth. Renovative capacity for wastewater would be only somewhat less than that of the fine-textured soils, due to the coarser texture of the Chili soil.

Cardington. This soil ranges from silt loam to silty clay loam with a high percentage of silt. The permeability is moderate near the surface and somewhat less permeable below eight inches of depth. The pH is acidic. Land slope ranges up to about six per cent. The substratum is clay loam till at about three feet of depth, and bedrock is greater than five feet. Renovative capacity is excellent.

Bennington. The characteristics of the Cardington soil series are similar to those of the Bennington, except that the silt content is slightly higher in the B Horizon and the clay content slightly higher with depth for the Bennington. Other differences are given in the detailed tables. Renovative capacity is excellent.

The following table summarizes particular selection criteria, and presents a potential rating for each criterion based upon anticipated crops and farm management.

TABLE IX-1

	Chili	Mahoning Ellsworth	Cardington Bennington
1. Hydraulic Capacity (1)			
Inches/Hour	2.0 to 6.3	0.06 to 0.2	0.2 to 0.63
(Equivalent Inches/ day)	(48 to 150)	(1.4 to 4.8)	(4.8 to 15)
2. Heavy Metal Removal (2)	99%	99%+	99%+
3. Nitrogen Removal (3)	85%+	95-99%	90-95%
4. Phosphorous Removal (4)	99%	99%+	99%+
5. Drainability (5)	Moderately Rapid	Slow	Moderately Slow

(1) See Table II-1 for Permeability.

(2) See Table II-1 for CEC, organic matter, and potential organic build-up.

(3) Based on reports at American Society of Agronomy and Soil Scientists of American, Joint Conference in Miami Beach, Florida on October 30, 1972.

(4) Parizek, R. R., and others. "Waste Water Renovation and Conservation" The Pennsylvania State University Studies, No. 23. University Park, Pennsylvania: The Pennsylvania State University, 1967.

(5) See Table II-1, County Soil Reports and "Definitions and Abbreviations for Soil Descriptions," (Form CF-123), U. S. Department of Agriculture, Soil Conservation Service, Berkeley, California, October 1966.

LAND TREATMENT OBJECTIVES

The objectives of land treatment are manyfold; however, they are summarized in three parts, as follows:

1. To renovate sewage effluent.
2. To recycle pollutants so that they become resources in our environment.
3. To create public economic and environmental benefits.

All three of the objectives received primary consideration in selecting land treatment areas. For instance, high level renovation of Akron wastewater may be accomplished on in-basin Mahoning soil land treatment areas, with the accompanying open space and greenbelt benefits, and a potential harvest of grass. The Chili soil areas provide for growing more typical agricultural crops; feed corn and other similar crops are suggested.

The western Ohio land treatment areas selected are aimed at creating a stronger and more viable irrigated agricultural economy using soils which presently have significant drainage handicaps. The recycling of nutrients, the drainage of land, and farm management efforts would help take this area into its rightful role as a major agricultural crop producing zone.[4]

The farm management techniques developed for this wastewater management study make it possible to meet the above-listed three objectives.

MAHONING-ELLSWORTH SOIL MANAGEMENT

A unique land management technique has been developed for the

Mahoning-Ellsworth soils which are very dominant in the Three Rivers Basin. Originally these soils were considered to be a major constraint to successful land treatment within the basin; however, detailed review of the technically-oriented soil properties, including test augering in the field and a study of topographic maps, has demonstrated that these soils actually provide a unique opportunity for widespread land treatment management.

The Overland Flow/Infiltration method has been developed to achieve the following specific goals:

1. Providing of massive blocks of perpetual open space in the Three Rivers Basin which would pre-empt continued and poorly planned urban sprawl for these areas.

2. Development of an irrigated grass crop for winter feeding of cattle.

3. Close-in land treatment sites for sewage effluent tertiary treatment where return flows will supplement recreational and esthetic stream flows, and provide supplemental water for water supply purposes.

Overland Flow/Infiltration System

Overland flow/infiltration, essentially a modified border irrigation method, is designed for tertiary treatment of significant quantities of treated sewage effluent on the Mahoning-Ellsworth soils. Narrow border strips having an average width of ten feet would be used. Widths would vary along their length to keep the borders running directly downhill. The purpose of this would be to prevent washing out of border dykes as a result of rodent activity or debris accumulation within the border.

Because these soils have low permeabilities in their lower horizons, they would be plowed to a depth of three and one-half feet on the approximate contour, which would be perpendicular to the borders. This would result in reduction of the density of the lower horizons and in placing more permeable soil at lower depths to facilitate better horizontal water movement. Drains would be placed at the depths of three to three and one-half feet under alternate border dykes, giving an average drain spacing of 20 feet.* Plowing would be accomplished prior to drain installation.

Individual risers would supply each mini-border. Several risers would be attached to a pipe manifold which would distribute the water from a valved outlet on the main buried pipeline. These valves would be operated by automatic controls which would sequence the irrigations. The advantage of this system over the use of solid sets for the same purpose would include a reduction in power costs, lower initial installation costs and lower maintenance costs than where risers and sprinkler heads would be exposed to damage by animals.

Renovation capacity, in terms of acre-inches per acre would be very high for this type of soil, particularly in the case of using this system for treatment of storm runoff. Large amounts of effluent could be treated close to its source, thereby greatly reducing water distribution costs.

Probably the most unique aspect of the system is that it combines the treatment processes of both the overland runoff method and the

*Drain spacing is based on soil permeability, required drain depth, crops, etc., and determined by tile spacing computations and agricultural engineering judgment.

infiltration-through-the-living-filter method to achieve some compounding of treatment efficiency. The treatment is accomplished by the water flowing horizontally across long stretches of dense grass, and then percolating through the soil zone for additional treatment. Irrigation application would be gaged so that there would be no surface flow left at the end of the mini-border run.

Runs of from 300 to 1,200 feet are contemplated on land which is deep-plowed at right angles to the runs to a depth of 3 to 3½ feet. The 20-foot spacing of drains under the borders would permit application rates of 150 inches per year for storm runoff. An annual rate of 90 inches per year has been chosen for domestic and industrial effluent. The continuous grass cover would permit an irrigation season of forty weeks per year. Weekly application rates of four inches would be reasonable, though for the first few years, lower rates of no more than about 2½ inches per week are recommended to allow the grass to establish a strong, dense root system and to give the soil structure a chance to undergo some re-structuring.

The crop would be a rough grass suitable for open-space greenbelt purposes, with harvesting potential as winter cattle feed. Layout of the system would contemplate adequate allowances for wildlife purposes. Design should be aimed at creating a bird and game refuge.

A diagram of Overland/Flow Infiltration methods are presented in Figure IX-1.

The vertical plowing to 3 or 3½ feet would turn the soil on edge,

distribute the permeability more evenly by putting the A Horizon on edge, and result in a fairly permanent permeability increase. Surface preparation would follow deep plowing and tile installation and would consist of shaping the borders and planting of a rough grass mixture containing numerous varieties of seed. Early testing would show which seed mixture was best for the locality.

When antecedent moisture conditions preclude irrigation, water would be stored in the large winter reservoirs. Not all fields would be irrigated on the same day, which would reduce the problem associated with a heavy rainstorm. If a heavy rainfall occurred without warning, runoff from a wet field could be collected at the lower end and routed onto the next field downhill. Overall surplus runoff would be routed to conveniently-located storage areas for pumping back through the system for treatment.

Harvesting of the grass for feed purposes will remove nutrients from the area for recycling back to cattle, and then to the cities. Feed lots would be situated in appropriate locations in agricultural areas where feed lot wastes can be appropriately treated in a manner similar to that of municipal wastewater.

Initially, lower application rates would be used while techniques were being developed and refined to best manage the overall operation. Over a period of time, the rates would be optimized, consistent with the best renovation and farming efficiency.

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation Phase: III Sub-Item: Irrigation

Overland Flow/Infiltration Method SHEET NO. 1 OF 1
Mahoning-Ellsworth Soils JOB NO. 712-70
BY KRW DATE 9/29/77

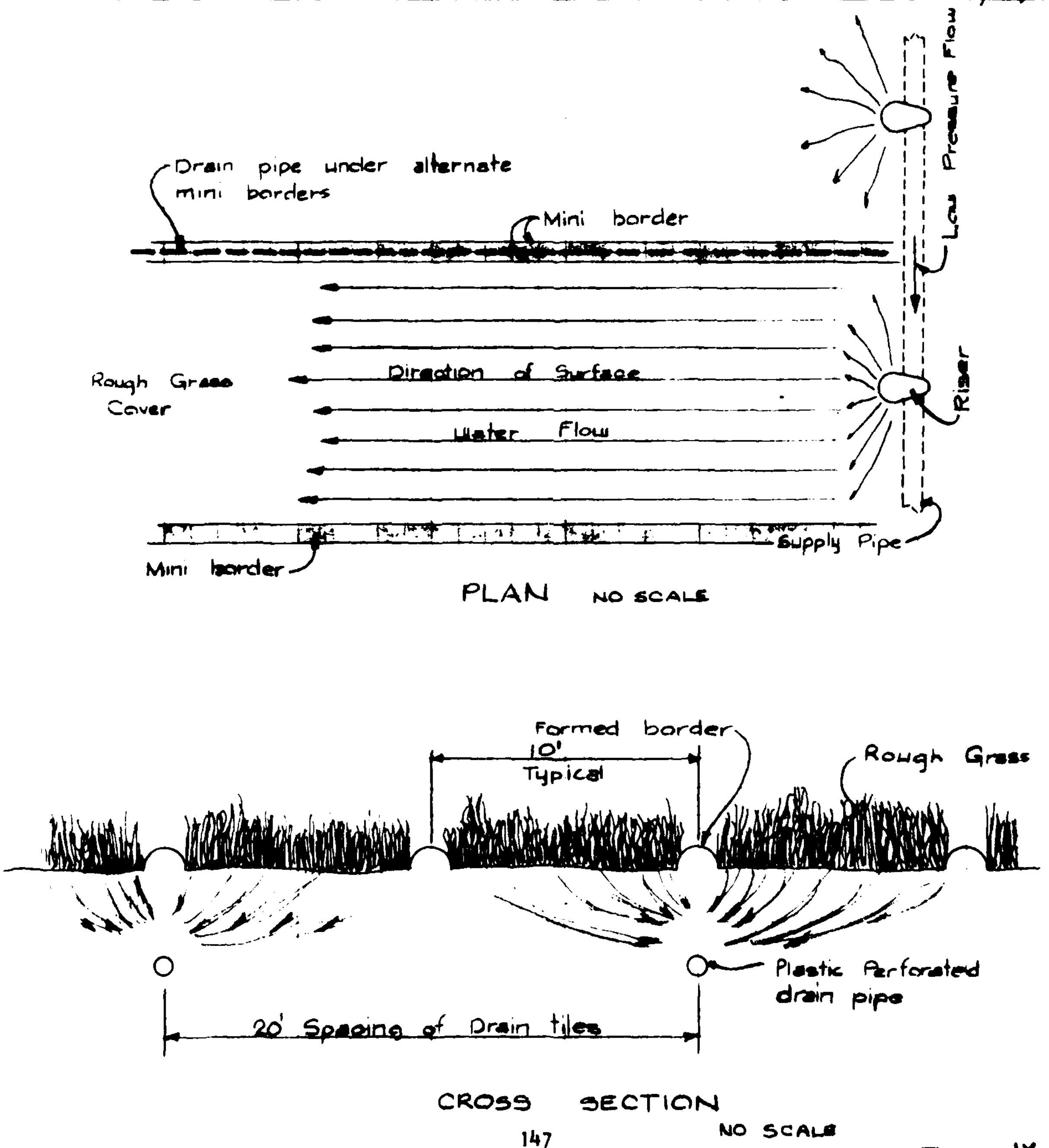


Figure IX-1

CHILI SOIL MANAGEMENT

The Chili soil is more suited to normal agricultural management practices; however, the rather high silt content would indicate the desirability of deep plowing which would invert the soil profile. Both solid set and center pivot irrigation rigs would be used, and, in some areas, border irrigation and ridge and furrow practices might be employed.

Irrigation application rates of 2 to $2\frac{1}{2}$ inches per day might be used at a frequency of once per week.* The total application rate of 60 inches per year is about optimum to match the nitrogen uptake of the crop and soil. Rates might be increased after some experience with the system, coupled with monitoring of the return flow.

It is expected that a sub-drain system of tiling will not be needed except in selected areas. The high permeability of the substratum would provide good drainage. Groundwater mounds would be controlled with spaced water wells.

The Chili soils are particularly well-oriented towards groundwater recharge management and development of water well fields which can be used for municipal/industrial water supplies and low flow stream augmentation.

Crops grown on the Chili soils would most logically be for cattle feed purposes; however, where ridge and furrow irrigation was used, there is the opportunity of developing cash crop truck farming operations for vegetables of various types. In all probability, feed corn

*With solid set sprinklers. Each type of water application must meet specific hydraulic constraints.

would be the most likely major crop on this soil.

Potential runoff from heavy rainfalls would be managed with infiltration, storage, and recycling techniques.

CARDINGTON-BENNINGTON SOIL MANAGEMENT

The fine-grained soils of Seneca, Huron, Crawford, and Richland Counties have been selected rather than the sandier and more permeable soils between Tiffin and Fremont because of the present drainage problems in those tighter soils, good crop yield potential, and high effluent renovation capability.

These soils would provide for meeting the following goals:

1. Provide for increased and more viable agricultural production to help meet the region's future food needs.

2. High level wastewater renovation with return flows suitable for water supply purposes, and to help meet the objectives of the Northwest Ohio Water Plan.

3. Drainage of lands indicated by the Great Lakes Basin Commission as being of a high priority for drainage improvements.

The land management plans for the Cardington-Bennington soils would include consideration of the following:

1. Hay and pasture land covering an area up to 25 or 30 per cent of the total management area would be irrigated by solid set sprinklers at an application rate of 50 or more inches per year having underdrains at 30 feet spacing. Water would be delivered at 50 psi, with droplet size controlled to a fine size to overcome silt puddling on the surface. Hay would be for winter feeding of breeding cattle.

2. Rough grass land covering perhaps five per cent of the total management area using the Mini-Border System would be utilized to raise rough grass for winter

feeding of cattle. Drain spacing would be at 20 feet. (See Figure IX-1.)

3. Growing of a high-protein, low-fiber Reed Canary Grass for cattle feed purposes would provide for excellent land treatment. With high nitrogen applications, this crop can have an uptake of some 300 pounds of nitrogen per year per acre. Reed Canary Grass would be irrigated with conventional center pivot irrigation rigs and drain tile spacing would be at 20 feet. Odd shaped areas would be irrigated using solid set sprinklers. It is anticipated that effluent would be applied at a rate of 75 inches per year; however, farm operators might choose, after operating experience, to significantly increase the application rates so that more nitrogen can be applied to improve the type of grass harvested. (See Figure IX-2.)

4. A combination of feed corn and grass laid out in strips could be irrigated with water sprayed into the grassed area by a center-pivot irrigation rig side-mounted flood jet. Tile spacing would be at 20-foot centers and an annual application rate of 75 inches would be used. (See Figures IX-3 and IX-4.)

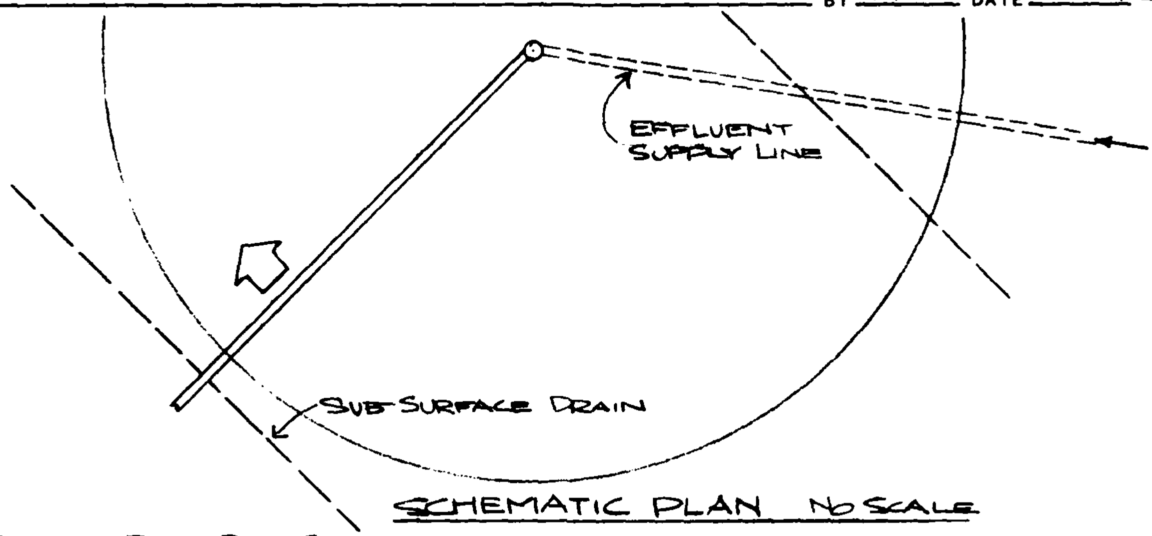
5. A corn crop laid out in double or triple rows, with each pair, or group, of rows separated by a trash-filled trough, receiving water applied by the center pivot-drip tube, is a potential land management technique for these soils. Drain tile spacing would be at 20 feet and an annual application rate of 75 inches per year would be used. (See Figure IX-5.)

6. Feed corn covering a portion of the land management area, using a center-pivot-drip tube method of applying water at the rate of about 75 inches per year. Drains would be installed approximately each 20 feet. The key to a successful program with corn on these soils is the drip-tube arrangement having a spacing of perhaps 14 feet; the water would be laid into a furrow having roughage (field trash), which, in turn, would provide for temporary water storage and high infiltration. Detailed planning of daily and weekly application rates to best manage the soil aerobic and anaerobic conditions for optimum renovation will be based upon field experimental work and further analyses. The drains could be laid out on straight lines, or in a circular fashion between the troughs. (See Figure IX-7.)

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation Phase: III Sub - Item: IRRIGATION

CENTER PIVOT RIG – REED CANARY GRASS SHEET NO. ____ OF ____
CARDINGTON – BENNINGTON SOILS JOB NO. 712-70
BY KRW DATE 11-21-72



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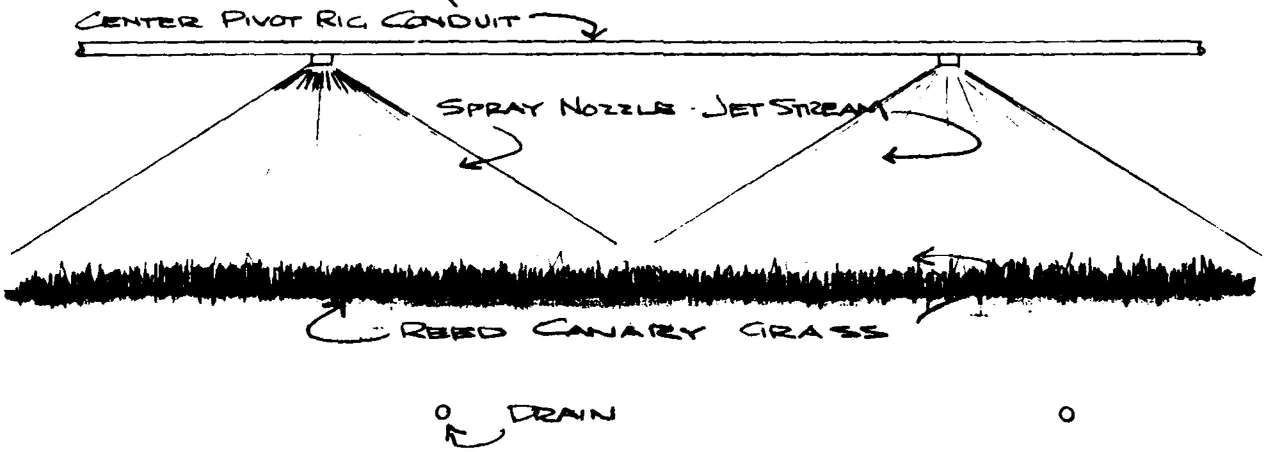


CROSS SECTION

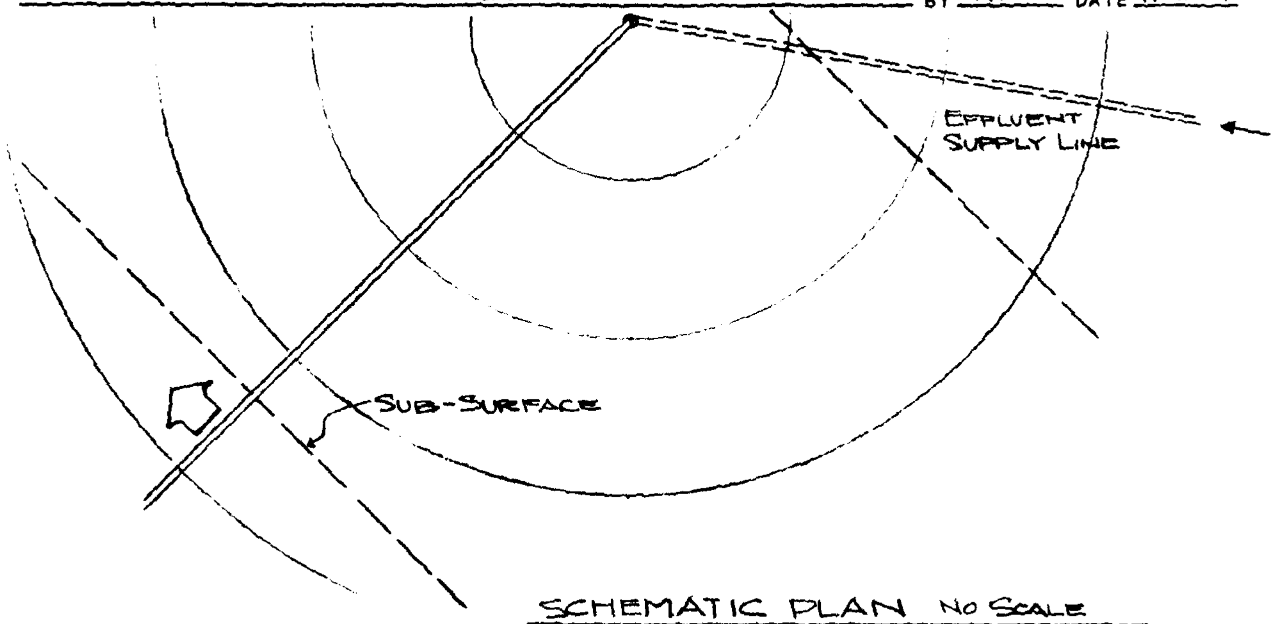
FIGURE IX-2

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation | Phase: III | Sub - Item: IRRIGATION

CENTER-PIVOT RIG — FLOOD JET / GRASS STRIP
CARDINGTON - BENINGTON SOILS

SHEET NO. ____ OF ____
JOB NO. 713-70
BY KRW DATE 11-21-72



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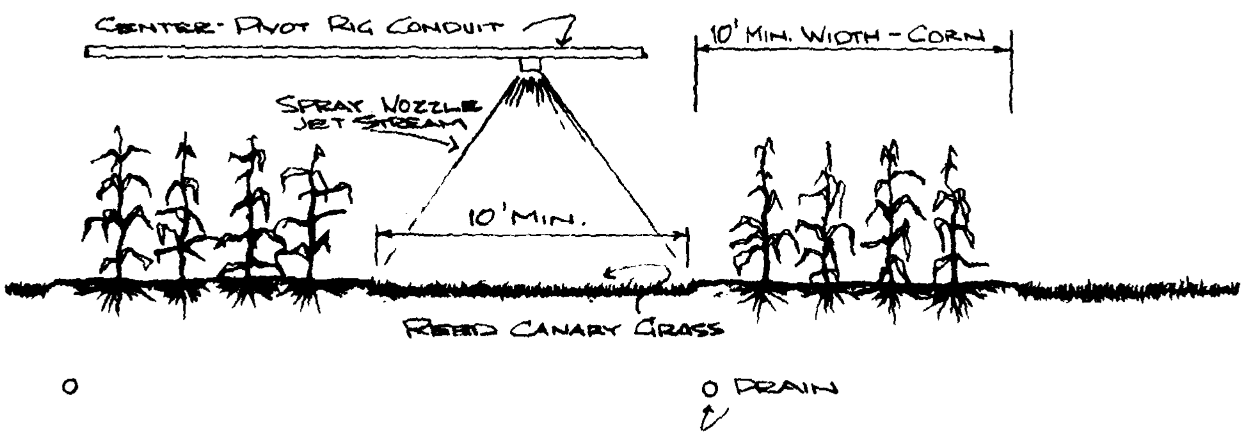


CROSS SECTION

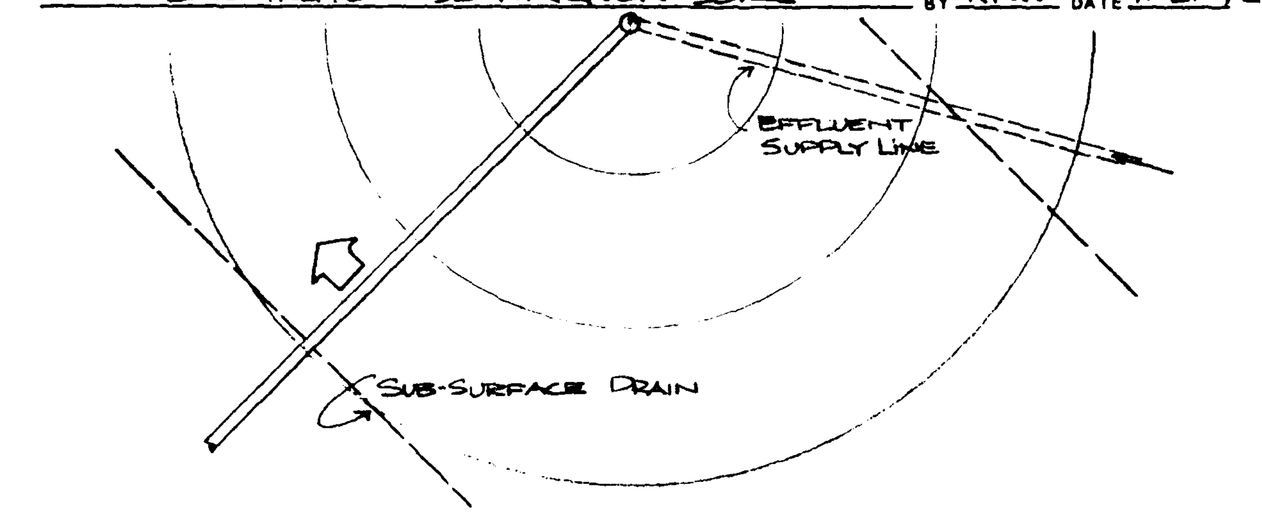
FIGURE IX-3

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

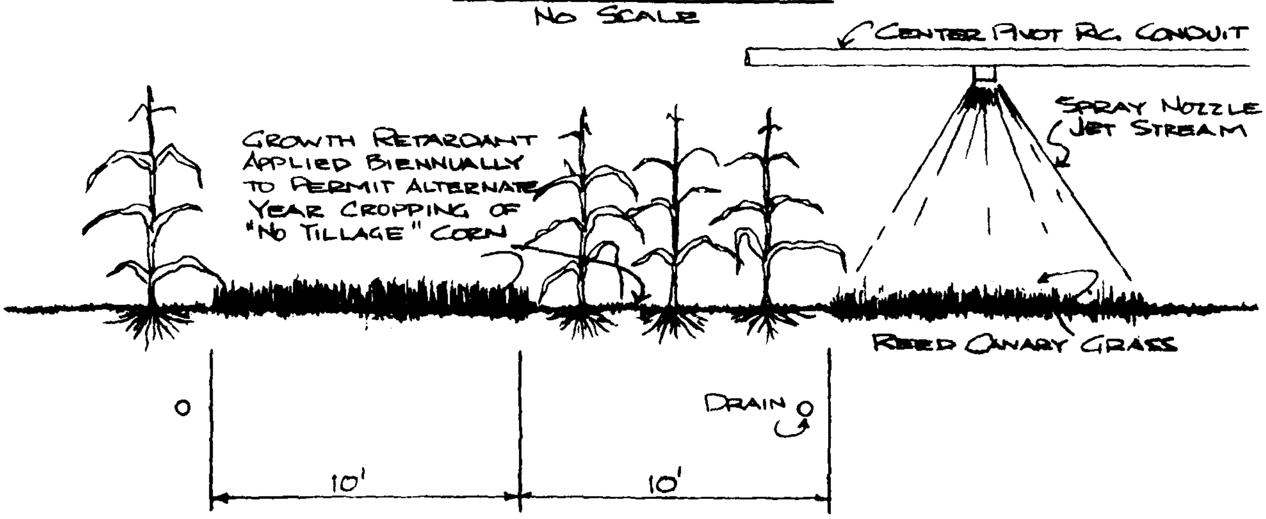
Land Treatment/Formulation | Phase: III | Sub - Item: IRRIGATION

CENTER PIVOT RIG - ABC METHOD (ALTERNATE BIENNUAL CROPPING METHOD) CARDINGTON - BENNINGTON SOILS

SHEET NO. ____ OF ____
JOB NO. 712-70
BY KRW DATE 11-21-72



SCHEMATIC PLAN
No Scale



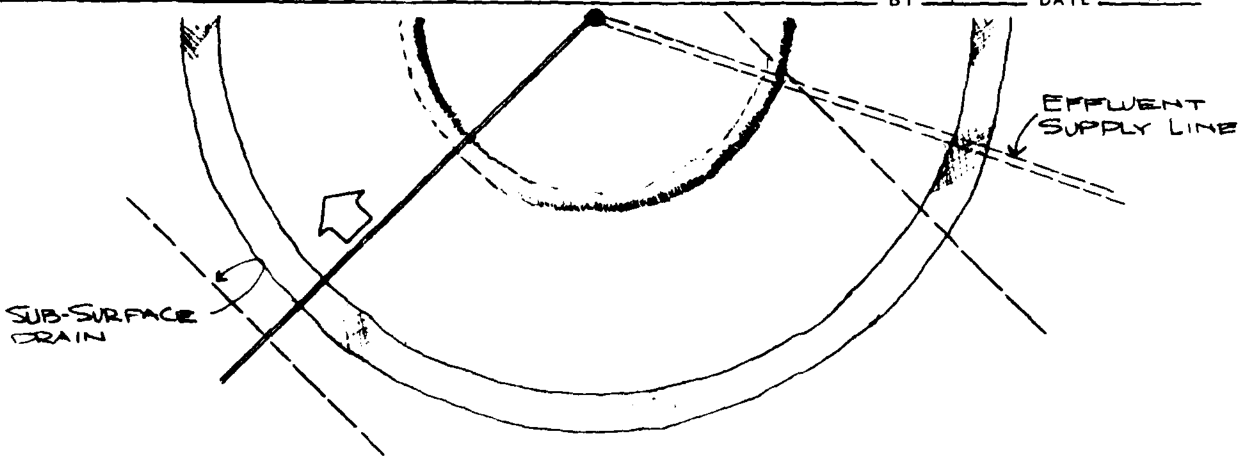
CROSS SECTION

FIGURE IX-4

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase: III   Sub - Item: IRRIGATION

CENTER-PIVOT RIG - 2 ROW CORN STRIPS   SHEET NO. ____ OF ____
CARDINGTON - BENNINGTON SOILS   JOB NO. 71Z - 70
BY KRW   DATE 11-21-72



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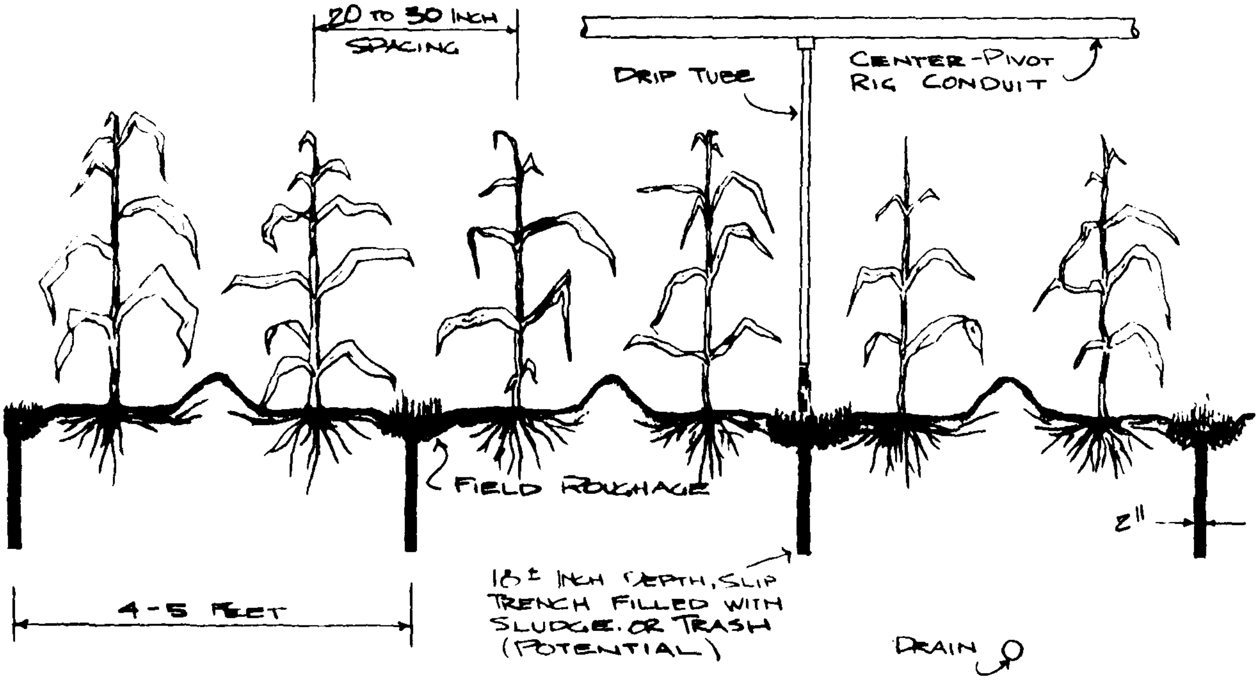


CROSS SECTION

FIGURE IX-5

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation — Phase: III — Sub - Item: IRRIGATION

CENTER PIVOT RIG - SLIP PLOW/DRIP TUBE — SHEET NO. ____ OF ____
CARDINGTON - BENINGTON SOILS — JOB NO. 71Z - 70
BY KRW — DATE 11-21-72

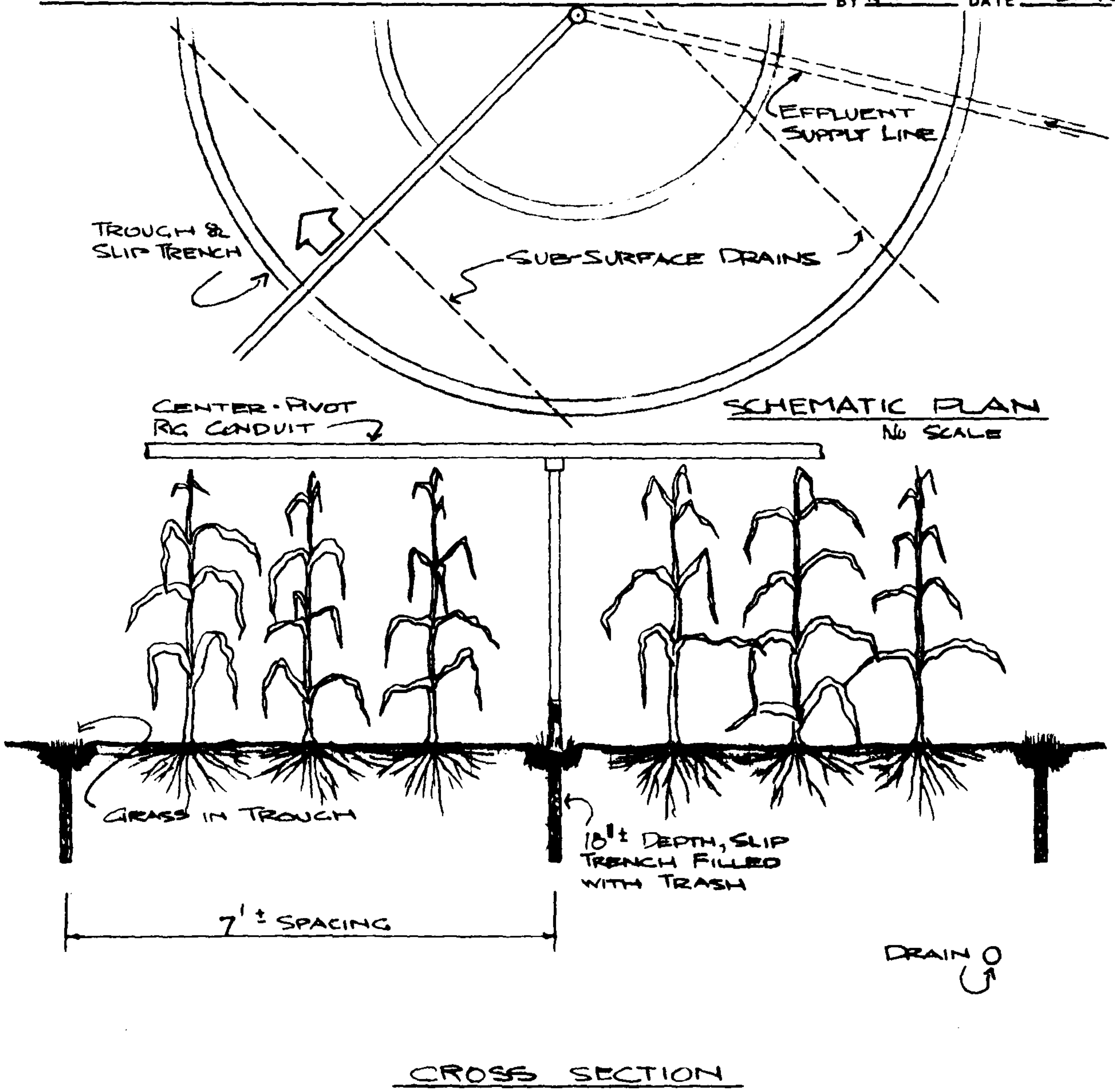
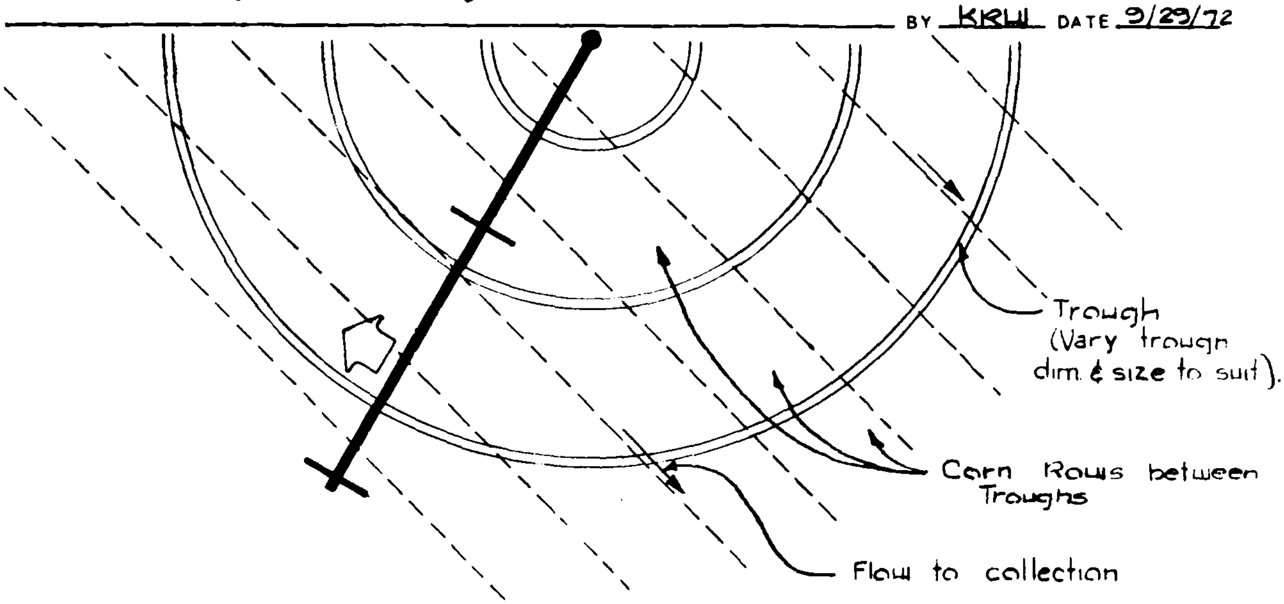


FIGURE IX-6

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation Phase: III Sub - Item: Irrigation

Center Pivot w/ Drip Tube System SHEET NO. ____ OF ____
Cardington - Bennington Soils JOB NO. 712 - 70
BY KRW DATE 9/29/72



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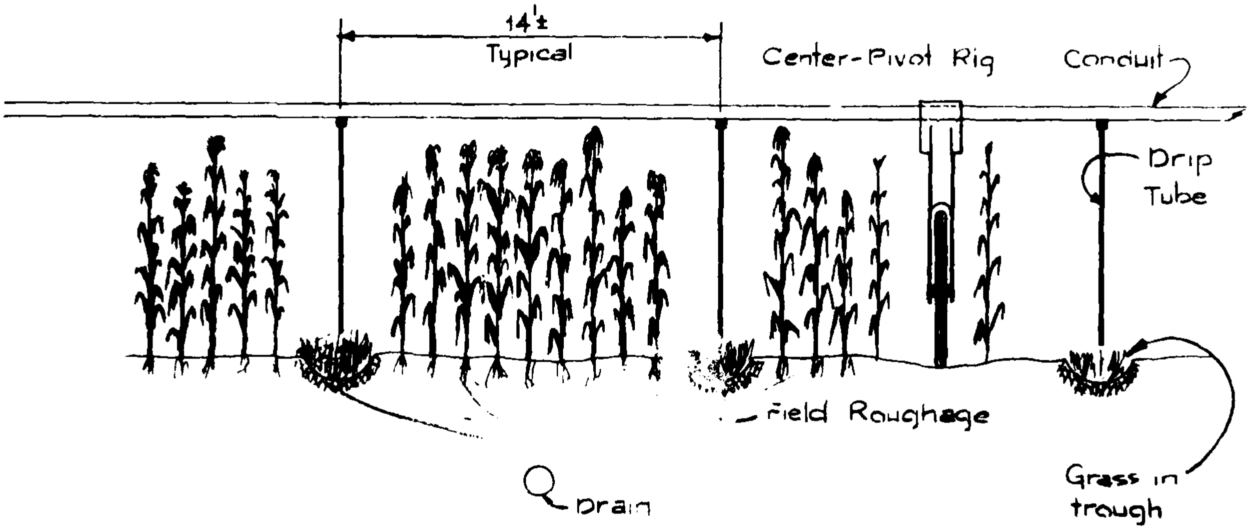

CROSS SECTION
NO SCALE

Figure IX-7

It should be pointed out that a variety of farm management techniques can be developed specifically for the Cardington-Bennington soils. The Center Pivot-Drip Tube method is only one possibility. Furthermore, the buildup of organic soil material, the potential for modification of the soil surface through limited sludge application, the use of solid set sprinklers, the somewhat closer spacing of drains, the development of new type center-pivot irrigation rigs, and other possibilities makes the development of other techniques using present-day technology practical.

Low delivery pressure needs for the drip-tube and flood-jet method tend to significantly reduce pumping costs, as well as the initial construction costs of the pipe distribution system.

Early action installations, coupled with small-scale plot development initially, would be used to verify the proposed methods and to improve upon them. It is believed that such experimental work would lead to many additional variations of land management, besides providing demonstrations of the suitability of circular farming. Circular farming operations are preferred with center-pivot irrigation equipment. Rectangular farming can be practiced, but it is less efficient and less convenient.

Early action demonstrations will also provide further detailed information on nitrogen balance. This is discussed in the Land Treatment Phase II Report.

DEEP PLOWING

The matter of deep plowing is of interest to agriculturalists, and some concern has been expressed by eastern agronomists over the value of deep plowing. Vast deep plowing has been done in Canada.

The experiments have been conducted on solonetizic soils, which are salty soils but are not called saline. There are about 20,000,000 acres of this soil in Canada and extending into the northern United States, in states like North Dakota. The deep plowing is done 18 inches to 24 inches deep and an 18-inch plow width is pulled by a 130-horsepower tractor; the cost ranges from $10 to $15 per acre.[6]

The A Horizon is acidic, with a pH of 5.0 to 5.5; the B Horizon has a high clay content, is very tight, and is underlain with a lime salt consisting of gypsum and calcium carbonates. The lime layer is brought to the surface, bringing the pH to neutral conditions. The cost of deep plowing, about $10 to $15 per acre, is a cheaper method of liming than transporting the lime by train and applying it with machines.

The experiments have been conducted for three to thirteen years; to date, there is no sign of this land reverting to its original condition. The symbiotic fixation of nitrogen has been stimulated and generally the microorganism population has increased. These lands are generally dry-farmed.

In .egard to sodium in the effluent, deep plowing would bring gypsum and calcium carbonates to the surface in sufficient quantities

to keep sodium from replacing the calcium and magnesium on the soil colloids. The sewage effluent would have an electrical conductivity of approximately 750 millimhos per cm and a reasonable sodium absorption ratio. Sufficient leaching is expected to occur through the soil column from both rainfall and irrigation applications to prevent sodium buildup.

As the effect of the calcareous material brought up from the C Horizon has dissipated, lime applications may be necessary to provide the calcium ions. This can be done by occasional applications of lime-conditioned sludge amounting to about 10 to 25 tons per acre. It is not anticipated that further deep plowing would be done to provide the lime because of the availability of lime deposits at a reasonable cost.

GENERAL

The discussion in this section of the Report has been presented primarily to demonstrate the variety of farm management techniques which might be developed to cope with constraints imposed by particular soil series which have limitations for utilization of more conventional irrigation and drainage methods. It is not meant to define a rigid limitation on choices of managment for these fine-grained soils.

It is anticipated that the agricultural fraternity would undertake mission-oriented research and development aimed at developing new techniques for particular soils and crops, with the age-old limit of agricultural economics being set in new dimensions on the basis that the

cropland can be synergistically utilized as a living filter for renovation of treated sewage effluent. Thus, the farmland would take on a new and additional vital role in serving the needs of society.

The potential of developing new methods for utilizing the soil to help in meeting the nation's need for clean water would hopefully lead to optimizing land use for agriculture and yet maximize the cleansing and purification potential as related to irrigation with wastewater.

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5. The Northwest Ohio Water Development Plan, prepared for the Ohio Water Commission, Department of Natural Resources, (Principal Consultant, Burgess & Niple, Limited), Columbus, Ohio, January, 1967.

6. Telephone call from Ralph Toren, Wright-McLaughlin Engineers, to R. R. Cairns, Officer-in-Charge, Research Branch, Solonetzic Soil Substratum, Canada Department of Agriculture in Vegreville, Alberta, on October 27, 1972.

SECTION X

RENOVATIVE CHARACTERISTICS

The application of wastewater to agricultural land provides a natural means of treatment utilizing the living filter of the soil. Wastewater will have received secondary treatment prior to irrigation so that the characteristics of the irrigation water will be equivalent to treated wastewater presently discharged into rivers and lakes.

The capability of the soil to remove pollutants from the wastewater is termed the wastewater renovative capacity. This capacity is often substantial due to the large surface area of the soil particles, the microbiological activity in the soil, the cation exchange capacity, and the organic content of the soil either at its natural level or built up artificially. It has been estimated that one ounce of clay represents a total surface area of about six acres. "Even in a teaspoonful of soil from the temperate regions, there may be 5 billion bacteria, twenty million actinomycetes, a million protozoa, and 200,000 algae and fungi. These crowds of micro-organisms carry on such fierce activitv on each acre that they expend an amount of energy equal to thousands of human beings living and working there." (Living Earth, p. 5)

EFFLUENT CHARACTER

The wastewater pollutants are in many instances resources for soil amendment. The non-beneficial constituents must be either stored or decomposed.

The irrigation water would have approximately the following concentrations of constituents:

TABLE X-1
IRRIGATION WATER QUALITY*

CONSTITUENT	MUNICIPAL - INDUSTRIAL AND COMBINED WASTEWATER (MG/L)	STORM RUNOFF (MG/L)	MUNICIPAL - INDUSTRIAL, COMBINED AND STORM RUNOFF (MG/L)
Suspended Solids (SS)	25	25	25
Biochemical Oxygen Demand (BOD)	15	15	15
Chemical Oxygen Demand (COD)	69	69	69
Total Dissolved Solids (TDS)	520	200	460
Nitrogen (N)	19.7	2.2	16.4
Phosphorous (P)	10.2	0.5	8.3
Heavy Metals	2.0	0.2	.7
Virus			
Bacteria			

* Based on the October, 1972 Contract Phase Report, Phase II - System Design and Estimate of Cost by Havens and Emerson, Ltd. and other communications with H. & E. Engineers. The 81% sewage effluent volume and 19% stormwater volume is representative of Plan 4 and Plan 12 for the Cleveland area plants. The average effluent concentrations are based on the use of biological systems without benefit of advanced wastewater treatment facilities.

RETURN FLOW QUALITY

The water undergoes renovation in the soil zone as it percolates through the living filter. Upon reaching the water table, or an artificial drain tile system, the water has had pollutants removed in varying amounts as indicated in the following tables for soils as selected in Section IX of this Appendix. The reader is referred to Land Treatment

Phase II Report for crop type and uptake and to Formulation Final Report for treatment goals.

TABLE X-2
RENOVATION OF EFFLUENT WITH CARDINGTON-BENNINGTON SOILS
BASED ON 75 INCHES/YEAR
MUNICIPAL/INDUSTRIAL/COMBINED EFFLUENT

CONSTITUENT	REMOVAL RATE (Percent)	RETURN FLOW (MG/L)
SS	99	< 0.3
BOD	99	< 0.2
COD	99	0.7
TDS	5-10	450-500 **
N	85-95*	< 1 to 2.5
P	99+	< 0.1
Metals	99+	Trace
Virus	99+	
Bacteria	99+	

TABLE X-3
RENOVATION OF EFFLUENT WITH MAHONING-ELLSWORTH SOILS
BASED ON 90 INCHES/YEAR
MUNICIPAL/INDUSTRIAL EFFLUENT

CONSTITUENT	REMOVAL RATE (Percent)	RETURN FLOW (MG/L)
SS	99	<0.3
BOD	99	< 0.2
COD	99	0.7
TDS	5-10	450-500 **
N	85-95*	1-3
P	99+	< 0.1
Metals	99	Trace
Virus	99	
Bacteria	99	

See references 3, 4, 5 and 6.

* The removal rate will depend on the crops grown, yields and product removal. Unexplained losses of up to 50% to the atmosphere may occur.[12]

** Average values are shown; lower and higher values are possible depending on rainfall and evapotranspiration rates.

TABLE X-4

RENOVATION OF EFFLUENT WITH MAHONING-ELLSWORTH SOILS
BASED ON 150 INCHES/YEAR
STORM RUNOFF

CONSTITUENT	REMOVAL RATE (Percent)	RETURN FLOW (MG/L)
SS	99	< 0.3
BOD	99	< 0.2
COD	99	0.7
TDS	5-10	150-200 **
N	99*	< 0.1
P	99+	< 0.01
Metals	99+	Trace
Virus	99+	
Bacteria	99+	

TABLE X-5

RENOVATION OF EFFLUENT WITH CHILI SOILS
BASED ON 60 INCHES/YEAR
MUNICIPAL EFFLUENT

CONSTITUENT	REMOVAL RATE (Percent)	RETURN FLOW (MG/L)
SS	99	< 0.3
BOD	95-99	< 0.8
COD	95-99	0.7-3.5
TDS	5-10	450-500 **
N	75-90*	2-5
P	98	< 0.2
Metals	95-99	Trace
Virus	99	
Bacteria	99	

See references 3, 4, 5 and 6.

* The removal rate will depend on the crops grown, yields and product removal. Unexplained losses of up to 50% to the atmosphere may occur.[12]

** Average values are shown; lower or higher values are possible depending on rainfall and evapotranspiration rates.

RENOVATION

The degree of renovation of wastewater applied to agricultural land depends upon the type of soil used, farm management procedures, type of crop, and irrigation application rates. Literature describing renovation and accumulation of constituents in soils varies from one extreme to another in regard to application rates, concentrations of critical constituents, and soil types.

The reader is referred to Wastewater Management by Disposal in the Land, Corps of Engineers, U. S. Army; and Assessment of the Effectiveness and Effects of Land Disposal Methodologies of Wastewater Management, Russell F. Christman and others at the University of Washington, for two reports which speak directly to wastewater management using land treatment and resulting renovative capabilities of soils. For the specific soils in question in the Lake Erie basin of northern Ohio these reports, coupled with the data in Table II-1 and specific reports and reviews for particular constituents, were utilized to determine the removal effeciencies as tabulated in this Section of the Appendix.[3, 6, 9, 10]

Discussions of certain pollutant removals follow.

ORGANIC REMOVAL

The maximum allowable BOD concentration in return flows is 5 MG/L and the assumed concentration in the irrigation water is 20 MG/L, with some estimates of 30 MG/L. Thus, a minimum removal efficiency of 75 percent to 83 percent is required. All soils considered in this study

exceed these removal rates.

An application rate of 75 inches per year with an effluent having a BOD concentration of 20 MG/L would result in the application of about 340 pounds per acre per year.

According to the Washington report,[5] soils which have remained aerobic under loading rates of hundreds of pounds per acre per day removed 90 percent of the BOD.

The soil capability to remove biochemical oxygen demand (BOD) can depend on the vegetative cover, aerated surface area and infiltration capacity. Anything that adds surface area of the soil interface will increase biological decomposition whether it be litter or living plants. Net BOD removal efficiency has been observed to be high even in the coarsest soils and highest infiltration rates studies, even though the removal efficiency per unit soil column decreased under such conditions.

In essence, most soils have a satisfactory capacity to remove BOD both physically and biologically, but in the soils selected, the limiting process will likely be biological, i.e., the decomposition rate. The latter process will be governed by the environment favorable to microbial life such as bacteria, algae and fungi.

The University of Washington report, Assessment of the Effectiveness and Effects of Land Disposal Methodologies, (page 59), cites the authors McGauhey and Krone (1967) who reviewed the limited amount of knowledge on refractory materials most apt to resist removal in the soil mantle and reach the ground water. They concluded that "only 30 percent of the

organic carbon in secondary treatment effluent could be assigned to chemical groups (Painter, 1961; Bunch, et al., 1961). Whereas 50 percent of the soluble organics in settled sewage are carbohydrates, only 10 percent could be ascribed to this category following secondary treatment. Most compounds after that stage were considered to be soluble acids."[5]

McGauhey and Krone (1967) conclude from the results of several workers that simple sugars, starches, hemicelluloses, celluloses and proteins decompose rapidly in soil, whereas such groups as lignin, waxes, tannins, cutins and fats are more resistant to decomposition.

NUTRIENT UPTAKE

Interactions between organic and inorganic nutrients are of a dynamic nature in soil systems. Before becoming available for uptake by plants, organic nutrients must be microbially converted to available inorganic forms (mineralization). This release of applied organic nutrients to available forms is a slow process; thus it is important to have sufficient inorganic nutrients present to ensure adequate plant nutrition. These inorganic compounds will be supplied either directly from the sewage effluent or through mineralization of the organic compounds.

Plant residues, as well as any future organic matter applied through sludge or effluent irrigation, comprise the bulk of organic content in the soil. The most important organic nutrients in the soil are compounds of nitrogen, phosphorous and sulfur. These compounds must undergo microbial changes before they can be utilized by plants. Organic compounds incorporated in pesticides and herbicides are insignificant in their contribution to soil fertility. These compounds generally remain unchanged in the soil for varying periods of time before being decomposed microbially.

The application of sludge would increase the existing organic matter content of the soil to a much greater extent than irrigation with secondarily treated effluent. This increase in organic matter content would result in an increased cation exchange capacity (CEC) in the surface horizon of the soil. Thus a greater amount of exchange cations could be held in the surface horizon of the soil which would be available for plant uptake.

The inorganic nutrients which are essential to plants in large quantities (macronutrients) are N, P, S, K, Ca and Mg. Essential micronutrients in plant nutrition are Cu, Zn, B, Cl, Mo, Mn, and Fe. Generally, micronutrients are not limiting to plants in soils which are neutral to acid in pH. In acid soils Ca, Mg and K are sometimes leached and could become deficient for plant requirements. The application of sludge and/or effluent would tend to neutralize acid soils, thus providing a "liming" treatment to some degree. The most important inputs from secondary treated sewage effluent would be nitrogen and phosphorous in their inorganic forms, whereas with sludge applications these nutrients would be predominantly present in organic forms. Heavy metals such as Pb, Hg, etc., are not known to be essential to plant nutrition, and excessive quantities of these elements could be toxic to plants. Both K and NH_4 cations can be fixed within the lattices of 2:1 clays such as montmorillonite. Since kaolinite is the predominant clay (1:1) found in northern Ohio, this loss of available K and NH_4 to plants is not felt to be significant.

Nitrogen

Nitrogen is the major constituent of the soil organic matter with respect to plant nutrition. Organic nitrogen in the forms of amino acids, purines, etc., is slowly converted microbially to ammonium and nitrate, which can be utilized by the plant.

In addition to nutrient uptake by plants, nitrogen is lost to the atmosphere largely through denitrification and ammonia volatilization.

Denitrification is a microbial process and occurs optimumly from pH 7-8; however, it may occur to lesser extents in acid soils. Reduced soil aeration and fresh organic matter both are necessary for denitrification. Larger carbon-nitrogen (C:N) ratios favor denitrification while small C:N ratios reduce denitrification. Significant denitrification can be obtained in a soil-plant system by alternating periods of irrigating and drying, providing that the other conditions are favorable.

Nitrogen can be "fixed" from the air by either symbiotic or non-symbiotic microorganisms. Symbiotic nitrogen fixation occurs in the root nodules of legumes, and the amount symbiotically fixed is dependent on the amount of nitrogen available in the soil from other sources. Research has shown that nitrogen fixation by legumes will be depressed if sufficient commercial nitrogen is applied. Applying regular doses of nutrients from sewage effluent should produce similar results.

Nitrogen from non-symbiotic nitrogen fixation is associated with several different microbial groups and is not expected to contribute much to the nitrogen supply. Rainfall can add minor amounts of nitrogen, perhaps ten pounds per acre per year.

Generally, grass species will have a greater nutrient demand per acre than row crops. This is due to the greater density of grasses and the possibility that they can be grown for a longer season than most row crops.

The nitrogen uptake rate for the Lake Erie basin of northern Ohio will vary from crop to crop, and with farming and cropping practices.

For the application rates of effluent of 75 inches per year on the Cardington-Bennington Association, 90 inches per year on the Mahoning-Ellsworth-Trumbull Association and 60 inches per year on the Chili soils, the expected rate of nitrate-N in the tile effluent should be consistently less than the ppm maximum, perhaps as low as 0.1 ppm.

Nitrogen "losses" to the atmosphere can be expected prior to meeting crop uptake needs. With excess application of nitrogen, the loss to the atmosphere will increase, the crop uptake will increase, and fine-grained soils will accumulate nitrogen. Actually, some researchers have reported nitrogen efficiencies from applications to uptake of no greater than 50 percent.[12] See the Land Treatment Phase II Report for further discussion.

Phosphorous

Phosphorous is generally immobilized within the upper layer of soil by precipitation with certain cations as insoluble complexes. Thus, in a finer textured soil, phosphates will be removed to a great extent due to the high CEC. Some organic phosphates have been known to move with the soil water to a greater extent than the relatively immobile inorganic phosphates. Under increasingly acidic conditions inorganic phosphates will become more mobile in the soil.

Phosphorous is removed by plants in lesser amounts than is nitrogen. Legumes will remove from 10 to 20 lbs/acre during a growing season while tree crops remove slightly higher amounts. Generally phosphorous removal varies from one-tenth to one-third of the nitrogen consumption by plants.

Phosphorous is found in secondary effluent primarily in the inorganic forms orthophosphate ($H_2PO_4^-$, HPO_4^{-2}), polyphosphate ($P_3O_{10}^{-5}$), and metaphosphate ($P_4O_{12}^{-4}$). The latter two are converted to orthophosphate in the soil in a matter of days. Assuming the average amount of these materials in the effluent to be about 10 mg/l P, an application rate of 60 inches effluent per year would amount to about 135 lbs/acre/year.

Phosphate ions are strongly adsorbed on the surface of aluminum silicate and iron or aluminum hydroxide minerals in the soil. This is an almost instantaneous process, so that nearly all phosphate can be removed from solution if enough adsorption sites are available in the soil particles. The latter condition is enhanced by high clay content of the soil. As the surface of particles in the upper layers of the soil become saturated with adsorbed phosphate ions, the dissolved phosphate percolates further downward until it encounters unsaturated particles. Thus the depth of soil becomes an important parameter for long-term phosphate retention. After six years of use, a four-foot deep soil at Penn State still was capable of 99 percent phosphate retention, with a potential life of over 100 years.[9]

Since phosphate adsorbed on soil particles is readily available for plant uptake, the capacity of the soil for phosphate retention is greatly increased by heavy vegetative growth, especially in the upper layers where plant roots are most numerous.

Adsorbed phosphate which is not taken up by plants is subject to reaction with various soil constituents to form insoluble precipitates,

It can also be adsorbed by diffusion into the mass of the soil particles. These are both rather slow processes and result in phosphate in a form which is not easily available to plants and microorganisms. They do provide, however, additional mechanisms for long-term soil retention of phosphorous.

In acid soils (pH less than 6.0), the primary precipitates are believed to be strengite ($Fe(H_2PO_4)(OH)_2$) and variscite ($Al(H_2PO_4)(OH)_2$). These are formed by reactions with Fe^{+3} or Al^{+3} in the soil, which are found in extremely abundant quantities, but which are not available for reaction except at low pH values. In neutral and basic soils, the most common precipitates formed are octocalcium phosphate ($Ca_4H(PO_4)_3$ 3 H_2O) and fluoroapatite ($Ca_{10}(PO_4)_6F_2$). These are formed by reaction with calcium, which is nearly always found in adequate quantities in soils of higher pH.

Soils containing substantial amounts of clay minerals or iron and aluminum hydroxides thus provide a high possibility for both short-term (by adsorption) and long-term (by precipitation and diffusion) retention of phosphates. When we combine this capability with plant uptake from proper crop management, the soils of northeastern Ohio can be anticipated to provide virtually complete retention of dissolved phosphates from secondary effluent.

While there is some indication that an overabundance of phosphate can cause plant damage, this is unlikely to occur under the dispersed application used in spray irrigation of effluents. The more widespread

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problem of phosphate deficiency can be reduced without disregarding possible future problems related to excess phosphate. In essence, "high" phosphate buildup would be related to time periods in excess of perhaps 100 to 150 years. During this period, the phosphate going to the stream will be minimal.

Potassium

Next to nitrogen, potassium is removed to the greatest extent from the soil by plants. Legumes can remove 50 to 100 lb. K/acre during a growing season while tree crops can remove well over 100 lb. K/acre. Leaching losses of potassium are small compared to the amount present in the soil. This is the result of the adsorption of potassium on the clay complex in soils. Potassium is found to be "fixed" within the lattice of certain 2:1-type clay minerals (illite). Since potassium is relatively immobile in soils and is taken up to a large extent by plants, it is felt that potassium would not be a significant source of environmental contamination under effluent or sludge applications.

TOTAL DISSOLVED SOLIDS

The soils of northern Ohio have been extensively leached, so that the additional water from irrigation would not result in larger additional concentrations in the drainage (tile) effluent. These soils are sufficiently acidic that the available calcium and magnesium would not be significant enough to precipitate bicarbonates. Under this environment, the tile effluent can be expected to contain the sulfates, chlorides and bicarbonates contained in the sewage effluent which constitute over

90 percent of the anions in the sewage effluent. The corresponding cations would consist mainly of calcium and magnesium and some sodium and potassium.

The accompanying table lists the average total dissolved solids (TDS) content for many of the streams which may receive treated wastewater from land treatment sites, either within or outside the Three Rivers Basin. The data in Table X-6 is for 1951-1952. Also shown are the periods of the year when the measured TDS is found to be higher, about equal to, or lower than the average figure. Table X-7 presents selected data for 1970.

A definite pattern exists in the data. During the winter and spring months (December to May, in general), the TDS is lower than average, while the period August to November generally shows higher TDS. During June and July, average TDS prevails. The variation is quite substantial, with a few exceptions which are noted below.

Downstream of the Cleveland Southerly Sewage Treatment Plant the TDS in the Cuyahoga River drops by more than 20 percent, and the seasonal variation is much less marked. This may be attributed to the infusion of a large (and relatively constant) amount of Lake Erie water.

Doan Brook shows the lowest TDS of all the streams flowing into the lake, with the exception of the Chagrin which also has a very constant TDS value.

The Chagrin and upper Cuyahoga Rivers have the lowest TDS of all, and also show only a slight seasonal variation in quality. These two

drainages contain by far the most natural vegetative patterns of all the streams considered. This tends to indicate that a fraction of the TDS, as well as variation in water quality, may be derived from the runoff from cleared agricultural lands.

The brackish Grand River has an extremely high content of calcium and sodium chlorides, apparently from natural sources, making it much different from any of the other rivers.

In view of the extremely high quality of most of the water supplies in the Three Rivers drainage, where nearly all of the water comes either from Lake Erie or the upper Cuyahoga River, indications are that the drainage of land-treated effluent into the streams of the area will not exceed the proposed 500 mg/l limit in TDS. The "use increments" of municipal use is on average about 250 ppm. The addition of this water may decrease the TDS of some of the streams into which the return drains during late summer and fall of the year.

Water management efforts need to be concentrated on the Grand River to determine if the total amount of dissolved solids flowing into Lake Erie from natural sources can be reduced. This is an area of study which would have a great effect on Lake Erie.

Table X-6 "Dissolved Solids Content in Lake Erie Tributaries for 1951-1952" and Table X-7 "Dissolved Solids in Selected Streams for 1970" follow.

TABLE X-6

DISSOLVED SOLIDS CONTENT IN LAKE ERIE TRIBUTARIES FOR 1951-1952

River	Avg. TDS (ppm)	Lower	Average	Higher
Portage	530	Dec.-June	July,Nov.	Aug.-Oct.
Sandusky	410	Dec.-May	June,July	Aug.-Dec.
Huron	380	Dec.-May	June-July	Aug.-Nov.
Vermilion	270	Dec.-May	June-July	Aug.-Nov.
Black	380	Dec.-May	May-July Nov.-Dec.	July-Nov.
Rocky	290	Jan.-May	June-July	Aug.-Dec.
Cuyahoga (Hiram Rapids)	158		Very little variation	
Cuyahoga (Independence)	500	Dec.-Apr.	May	June-Nov.
Cuyahoga (Cleveland)	390	Jan.-Apr.	May-July Nov.-Dec. (Much less variation than others)	Aug.-Nov.
Doan Brook	260		No pattern in variation	
Chagrin	200	Jan.-Apr.	May-July (Less variation than others)	Aug.-Nov.
Grand	4000	Nov.-May	-- (High Ca & Na Cl)	May-Nov.

TABLE X-7 *

DISSOLVED SOLIDS IN SELECTED STREAMS FOR 1970

River and Station	Dissolved Solids in MG/L		
	Average	High	Low
Sandusky River Below Fremont	410	706	196
Huron River Below Milan	430	580	146
Vermilion River Near Vermilion	340	440	254
Black River at Elyria	500	1010	172
Cuyahoga River at Independence	590	1010	314

* See reference 13.

HEAVY METALS

INTRODUCTION

For the purposes of this report, heavy metals can be defined as those metallic and other chemical elements which are not major constituents of most natural waters, and include the elements aluminum, arsenic, barium, beryllium, boron, cadmium, cobalt, copper, chromium, iron, lead, manganese, mercury, molybdenum, nickel, silver, strontium, vanadium, and zinc. These metals are generally found in the natural waters in extremely minute quantities, but are added in much greater amounts as a result of man's activities, especially through manufacturing operations. If the concentrations of some of these metals reach a critical level, they can be toxic to man, or plants and animals. However, the metals can be monitored, crops can be rotated, and the fields managed to preclude the development of problems.

Treatment Considerations. The presence of heavy metals in irrigation water is of special concern because they:

1. Are conservative, that is, they are generally non-degradable,
2. Are in general quite actively involved in biological processes, and,
3. Tend to be concentrated in the food chain. Most of them are essential for growth but become toxic to microorganisms, plants or plant consumers at elevated levels.

The general situation presented by these non-degradables may be considered from a mass balance approach, which may lead to the following symbolic formulation:

$$T = Q_E - L - S$$

$$T = Q_E - L - S$$

All terms are in units of lb./day, element by element, where T represents the treatment required for heavy metal removal prior to irrigation, Q_E denotes the existing quality of the combined input wastewaters (domestic, industrial and storm), L represents the highest input that the most sensitive organism can tolerate and S relates to storage capacity of the soil. If impaction does not occur prior to the attainment of a steady state, S approaches zero and

$$T = Q_E - L$$

This rather ideal simplification is introduced because it serves to illustrate a number of crucial elements, how they interrelate, and thus the potential design and management alternatives.

To some extent, each term is manageable, i.e., can be varied, even considering real-system constraints. Most likely the major source of metals is industrial waste. If industries are required to treat their effluents prior to release, or pay for the treatment, some may find it feasible to alter processes, recycle waters, or recover metals in-house.

Thus, conceivably, Q_E might be improved, i.e., metal inputs to the system reduced. The present value of Q_E can be determined.

Obviously, many treatment alternatives, T, exist in either primary or secondary treatment with regard to type of treatment unit, degree of removal, and area location. Ideally, design of the required treatment would be based on:

$$Q_E - L - S$$

Of these, L and S are virtually unpredicatble at present in terms of special quantifiable numbers; therefore, optimal design *a priori* of the treatment system for heavy metal removal is impossible at this time.

By incorporating system flexibility, by close monitoring to determine L and S, by selecting crops with much higher L values, e.g., fibrous crops vs. food stuffs, and through operational and incremental design alterations, an optimal design may be approached in the future. Thus, future optimization can be built into the design and construction of the land treatment works.

As we have said, both L and S are to some extent manageable. For example, by liming the acidic soils, available storage may be increased and release to receiving streams decreased. Likewise L may be managed by agricultural technology, e.g., plant type or even species or alteration of soil pH (liming of acidic soils may decrease Cu, Zn, Mn, and Fe uptake while increasing anion uptake such as $MoO_4^{=}$).

Loading Limitations. The capacity of a particular soil to retain heavy metals could be limited by any one of four factors as generally discussed above; the first one of these to be exceeded determines the effective capacity of the soil. These factors are:

1. The physical capacity of the soil to retain metals, either mechanically or chemically. If this is exceeded, further metallic ions in solution will pass through the soil into receiving streams.

2. Damage to soil microorganisms. Metals which are toxic to these organisms could result in a reduced capacity of the soil to retain other constituents, degrade the applied BOD, or support plant growth.

3. Plant damage. Concentrations of metals toxic to plants could result in reduced yield or specific damage to some critical part of the plant's growth cycle.

4. Toxicity to animals consuming the plants. If the plants are to be consumed by animals or people, sufficiently high levels of certain metals could result in poisoning or illness of the animal consuming it, without obvious damage to the plant itself.

Most critical of all is the possibility for chronic human toxicity (versus the more obvious acute toxicity) due to metal recycled through the food chain. Relating cause and effect is extremely difficult because of numerous adverse influences from other sources which need control. Up to now, there has been little or no control (or even measurement) of the concentrations of these elements found in our air, surface and ground waters, sewage effluents discharged to streams and lakes, or in the food we consume.

The U. S. Bureau of Reclamation, which has been developing irrigation projects throughout the 17 western states since about 1902, has no official heavy metal standards, and they have not systematically measured such constituents. The U. S. Geological Water Supply Papers giving water quality records do not normally report heavy metals, except iron. This illustrates the lack of concern in the past relative to heavy metals. Land treatment with treated effluent is expected to stimulate more activity in this long ignored field, such activity probably falling upon the shoulders of

agronomists, health scientists, and animal specialists.

Little is known about damage to soil microorganisms, but its effect is most likely to be felt indirectly, in the form of plant damage. Toxicity to plants and animals is a complex function of many factors, including the type of plant grown; the concentration of a particular metal in the effluent; the amount of the same metal already in the soil before irrigation; the chemical form of the metal, which determines its availability to plants; and the effects of other chemical constituents, both in the soil and in the effluent. Little information is presently available in general regarding the chemical factors; however, biological factors (types of plants) can be easily controlled.

Applied Criteria for Classification of Soils. The soils under consideration are classified only according to their physical capacity to retain heavy metals in general. In the absence of specific trace metal analyses of the soils, this physical classification is based on the following factors:

1. Clay content. Since much of the adsorption of the heavy metals takes place on the surface of aluminosilicate particles, soils with higher clay contents have greater capacities for retention of metals.[4] CRREL Report, p. 49, 50.

2. Cation exchange capacity (CEC). Most of the clay content of soils in northeastern Ohio is in the form of kaolinite, which has a low CEC in comparison to other clay minerals. Therefore, this is a less important factor than the adsorptive capacity.[5] Washington Report, p. 77.
3. Organic content. Organic matter contributes both to adsorption and ion exchange mechanisms of heavy metal ion retention. Therefore, organic soils are more desirable than those with low organic contents. (High organic content could also increase metal uptake by plants through chelation.)[3,4,5]

4. pH. Neutral or alkaline conditions enhance both the adsorption and exchange mechanisms of metal ion retention. Therefore, higher pH's are generally more desirable. An exception to this rule is molybdenum, which is found in solution in an anionic state, as $MoO_4^{=}$, which is retained more easily at low pH.[5]
Washington Report, p. 95.

5. Depth. As surface layers of soil become saturated with heavy metals, the solution percolates downward. The deeper the soil, the greater the adsorptive capacity available.

PROBLEMS WITH SPECIFIC METALS

If it is assumed that the secondary effluent contains average concentrations of dissolved metals, the concentrations of chromium, copper, iron manganese, nickel, lead, and zinc deposited in the soil, even after a century of application at a rate of 75 inches effluent per year, would be only a fraction of the naturally occurring amounts found in some soils. All of these ions would probably be retained almost completely. The major potential problem, concentration in the upper inch or so of the soil, will be alleviated by plowing of land.

Concentrations of boron in some effluents are high enough that the total accumulating after many years could approach the upper limits found naturally, barring plant uptake and removal. Boron, however, is an essential plant nutrient and could be expected to be removed by plants. The amount found in some effluent is high enough to cause damage in certain sensitive plants; therefore, the boron content of both the effluent and the plants grown on the land should be monitored and, if necessary, altered in order to produce maximum agricultural yields.

The recommended limit of cadmium in irrigation water is extremely

small (0.005 mg/l).[14] The U. S. Public Health Service, however, has set a recommended limit for cadmium in public drinking water supplies which is twice as much (0.01 mg/l) as for irrigation water.[14] This irrigation water value is based on the known toxicity of cadmium to man and the unproven, but potential, possibility that it might be concentrated in toxic quantities by certain food or forage plants. Until further investigations are performed to determine the cadmium cycle in plants, both effluent and plants should be carefully monitored. If a questionable situation should arise, means for the removal of most cadmium at its source (factories, etc.) should be considered. (See also reference 15.)

Mercury is toxic to man in very small quantities, and is known to be concentrated by certain organisms, such as swordfish. While the amount found in secondary effluent is likely to be much smaller than that which would be dangerous, this element should also be monitored in both effluent and plants.

The recommended limit of molybdenum in irrigation water is also quite small (0.005 mg/l).[14] There is serious question about the interpretation of experimental data which has led to this figure, however, and it appears far more likely that the molybdenum in the effluent will supply a need (Mo is an essential plant nutrient), than that it will contribute to molybdenosis in animals grazing on crops grown with spray irrigation of secondary effluent.

CLEVELAND HEAVY METALS

Studies by AWARE of the actual industries in Cleveland and

their anticipated discharge to municipal sewerage systems in the year 2020, using trend forecasting techniques and no major re-orienting of recycling philosophy, has resulted in projections of heavy metals loads.

The heavy metal discharges by industry, as estimated by AWARE, into the municipal sewage collection systems of Bedford, Cleveland Easterly, Cleveland Southerly, Cleveland Westerly, Summit, Twinsburg, and Willoughby were totalled for the year 2020 for the AWARE alternative 5A. Alternative 5A represents the least amount of in-house heavy metal control by industry of the treatment alternatives studied, and its objective is described by AWARE as follows:

> "Goal II modified to not require demineralization or removal of heavy metals except for direct discharge to waterways or where metals would interfere with biological treatment." (Aware Report, Phase II, p. 12)

Heavy metal concentrations in soil, assuming land treatment, were compared with four metal toxic levels as reported in the British Pollution Control Journal in 1972 on the basis of 50 and 100-year irrigation periods. The results are presented in Table X-8. Conclusions are as follows:

1. The copper, chromium, cadmium, nickel, zinc, and lead concentrations will still be within reasonable limits after 100 years of application to the same soil without deep plowing farm management.

2. The discharge levels assume no improvement in industry metal recycling efforts for the next 100 years over the present practices as indicated by AWARE studies, and no special effort by related industry to reclaim valuable metals which will become more scarce in the future.

3. Deep plowing would reduce the concentration levels of the heavy metals in the soil as indicated in Table X-8.

4. The soil provides a storage location for these metals where they can be controlled and managed.

The matter of heavy metal accumulation in the soil is a "guess" because the soils being considered are extremely efficient in removing and storing such metals contained in wastewater from metropolitan areas. The capacity for storage is huge, ranging up to 500 or 1000 years in many instances. Before this time, toxic levels of some metals would be reached. Thus, heavy metal accumulation management is mandatory.

Routing of heavy metals to land, rather than to water or air, provides an opportunity for management not found in the other mediums. The excellent field studies being conducted at the University of Illinois under an E.P.A. grant have confirmed that heavy metal accumulation in soil can be managed, and that the longer termed problem can be avoided by field monitoring and management.[17]

TABLE X-8
SOIL CONCENTRATIONS OF HEAVY METALS FROM LAND TREATMENT

Heavy Metal	Yr. 2020 Loads (1) (lb/day)	Yr. 2020 Loads with 62% Removal (lb/day)	Concentrations with 653.9 MGD (Incl. S.W.) (mg/l)	Irrigation Rate of 75"/Yr. Annual Loading (lbs/Ac.)	Irrigation Rate of 75"/Yr. Annual Concentration (2) (PPM/Ac.-12")
Silver	9.8	3.7	0.00068	0.0115	0.0029
Copper	1,797	682	0.125	2.12	0.53
Chromium	2,876	1,091	0.201	3.41	0.85
Cadmium	67	25.4	0.0047	0.075	0.019
Nickel	1,793	681	0.125	2.12	0.53
Lead	5.5	2.1	0.0039	0.066	0.016
Zinc	2,227	844	0.155	2.63	0.66
Iron	13,788	5,230	0.965	16.4	4.1

Heavy Metal	Irrigation Rates of 75"/Yr. - 90"/Yr. 50-Yr. Concentration in PPM			100-Yr. Concentration in PPM			Toxic Levels by British Paper (3)	Range of Natural Soil (4) (PPM -24")
	12" Layer	18" Layer	24" Layer	12" Layer	18" Layer	24" Layer		
Silver	0.14- 0.17	0.11- 0.13	0.07- 0.08	0.29- 0.35	0.21- 0.25	0.14- 0.17		0.1-1
Copper	26.50-31.80	19.90-23.90	13.25-15.90	53.00-63.60	39.80-47.80	26.50-31.80	100-200	2 -100
Chromium	42.50-51.00	31.90-38.30	21.25-25.50	85.00-102.00	63.80-76.60	42.50-51.00	400	5 -1000
Cadmium	0.95- 1.14	0.71- 0.85	0.47- 0.56	1.90- 2.28	1.43- 1.72	0.95- 1.14		---
Nickel	26.50-31.80	19.90-23.80	13.25-15.90	53.00-63.60	39.80-47.80	26.50-31.20	49-100	5 -500
Lead	0.80- 0.96	0.60- 0.72	0.40- 0.48	1.60- 1.92	1.20- 1.44	0.80- 0.96		2 -200
Zinc	33.00-39.60	24.80-29.80	16.50-19.80	66.00-79.30	49.50-59.40	33.00-39.60	125	10 -300
Iron	205.00-246.00	154.00-185.00	102.50-123.00	410.00-492.00	307.00-369.00	205.00-246.00		1.4-4.2%

Notes:
1. Loadings for Alternate 5A - Bedford, Cleveland Easterly, Cleveland Southerly, Cleveland Westerly, Summit Unsewered, Twinsburg and Willoughby -- As per AWARE Industrial Waste Study, October, 1972.
2. Weight of an acre of soil 12 inches deep = 4,000,000 lbs.
3. From 1972 paper of British Pollution Control Journal entitled, "Effects of Toxic Metals in Sewage on Crops."[11]
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SECTION XI

STRIP MINED LAND RECLAMATION

The major solids by-product of any wastewater treatment system is the sludge which is reclaimed from the water. This sludge is a mixture of the solid materials removed in the primary, secondary, and, in some cases, tertiary phases of the treatment. It contains both inorganic particulates and decayed organic matter. After suitable digestion and stabilization, the latter component has been stripped of volatile constituents and odor-producing matter, as well as most of the pathogens originally present. The final product is a thick slurry containing three to eight percent of finely divided solid particles. The organic content is very high, and the sludge contains substantial amounts of phosphorous and organic nitrogen, two vital plant nutrients. It also contains about 80 percent of the heavy metals present in the raw sewage, the total amount depending on the degree of pre-treatment before discharge of industrial wastes to the sewage system. The large quantities of sludge produced, coupled with the high content of organic matter and plant nutrients, make this a valuable resource which should be utilized to the maximum benefit.

A unique opportunity for doing this exists in the Cleveland-Akron area. To the south and east are vast areas of land which have been strip-mined for coal, more than 190,000 acres lying within a 150-mile radius of Cleveland. A county-by-county list of strip mine acreages for the entire state is shown in Table XI-1 . (Actual area must be reduced by about 25

per cent to account for lands which have been mined more than once). The data are also shown in Figure XI-1.

During the stripping process, the topsoil is generally buried beneath sterile, broken sandstone, some limestone, and some shale. Under the new Ohio reclamation law, however, the topsoil is removed from the land prior to mining. Reclamation results in approximately one foot of soil being returned as a cover.

Where sandstone is the major outcrop, there is often no runoff, with the rain percolating downward. Where shale is exposed at the surface, the raindrops pulverize the material, creating fine matter which is rich with sulfides, minerals, and oil. This is highly impervious to water and is toxic to plants. The shale residual is acid and high in iron, aluminum, and other metals. This latter condition leads to significant erosion.

Where sandstone is exposed, the water percolates through the sandstone, and the water and oxygen oxidize the various sulfides found in the sandstone, shale, and coal, with resulting sulfuric acid. The acid then solublizes other minerals containing heavy metals. Concentrations include the following:

Calcium	400 ppm
Magnesium	250 ppm
Manganese	500 ppm
Iron	500 ppm
Sulfates	2,500 ppm
Aluminum	100 ppm

Where the coal contained relatively high amounts of limestone, the alkilinity of the limestone completely neutralizes the acidity and

results in a percolating water pH of 7.5 to 8.0.

In all cases, the runoff water, or percolating water, is polluted, and this adversely affects downstream aquatic life. The characteristics of the mined land leads to a general arid condition.

Some of the recent reclamation work done on land high in limestone resulted in very good ground cover. Here Crown Vetch has been used because of its ability to tie up nitrogen from the air and grows under dry conditions. However, many other plant species, grass as well as legumes, are used in reclamation.

In areas of no reclamation, the decay of the sparse vegetation which grows on the spoil banks will slowly build up soil. However, this natural process period might take centuries. On the other hand, sincere efforts to reclaim the land have, in some cases, produced good range country where limestone is abundant. In areas high in sandstone, where no limestone is found, restoration of land has been found costly and difficult. It is necessary to provide a substance to the land to make it fertile, the addition being organic matter and needed nitrogen.

Restoration of strip-mined land requires, in addition to topsoil, several basic steps:

a. Provide a supply of nitrogen and phosphorous.
b. Increase the moisture-retention capacity of the soil.
c. Buffer the system to reduce acid conditions at depth.
d. Improve the physical characteristics of the soil.

In those cases where the land is covered with vegetation, and where reclamation is properly undertaken, the movement of air and water into

the spoil will be reduced, resulting in less acid production.

Much of the strip-mined land in Ohio has been left in very bad condition, but where the lands have already been leveled, land reclamation utilizing sludge can result in great benefits at low cost.

It is believed that much of the sludge should be first used on land having significant sandstone, which is the primary type of land now being mined in southeast Ohio.

The limestone land has a better natural restoration capacity. Sewage treatment plants producing lime sludges are quite suitable for lands containing little or no limestone, and where high acidity conditions exist.

Sludge would be removed from the digester as a liquid, concentrated to the desired degree if necessary, and transported via pipeline to the strip-mined areas. An existing abandoned coal slurry pipeline leads from Eastlake to Cadiz, in the heart of the strip-mined area, and could possibly be used with only slight modification. If its condition should prevent use directly, the existing right-of-way could still be utilized. This pipeline passes just a few miles east of an extensively mined area south of Canton, and could also be used for restoration of lands in this area.

At the end of the pipeline, a small reservoir would be constructed for storage purposes. From this storage site, the sludge would be transported via tank truck directly to the lands currently being restored, the tank trucks accompanying the applicator on its rounds. If necessary,

the pipeline could be extended every few years to reduce the distance to the lands then being treated.

Treatment of the strip-mined lands with sludge, coupled with appropriate planting and liming, where necessary, should permit immediate growth of numerous native species of plants. If the lands are permitted to revert, the soil-building process would then continue at a rapid rate. The land could be used for wildlife and recreation purposes, with some grazing permitted on areas seeded to grass instead of trees. After just a few decades, the natural restoration process will have proceeded to a degree that the land could then be used for any purpose, including agriculture.

Excellent research is being undertaken presently by personnel from Case Western University. The knowledge and results of their work should be used in the final planning and design of strip-mined land reclamation using sludge. Questions relating to optimum rates of application, plant species best suited, and frequency of application can best be answered by conducting additional field experiments as a part of final planning. These experiments can also help to answer questions related to the economics of large-scale sludge applications. However, in all of this work, an overriding consideration must be that our generation is trustee of the environment for future generations. This generation should look at the land use practices of today from the perspective of those living in Ohio during the next century.

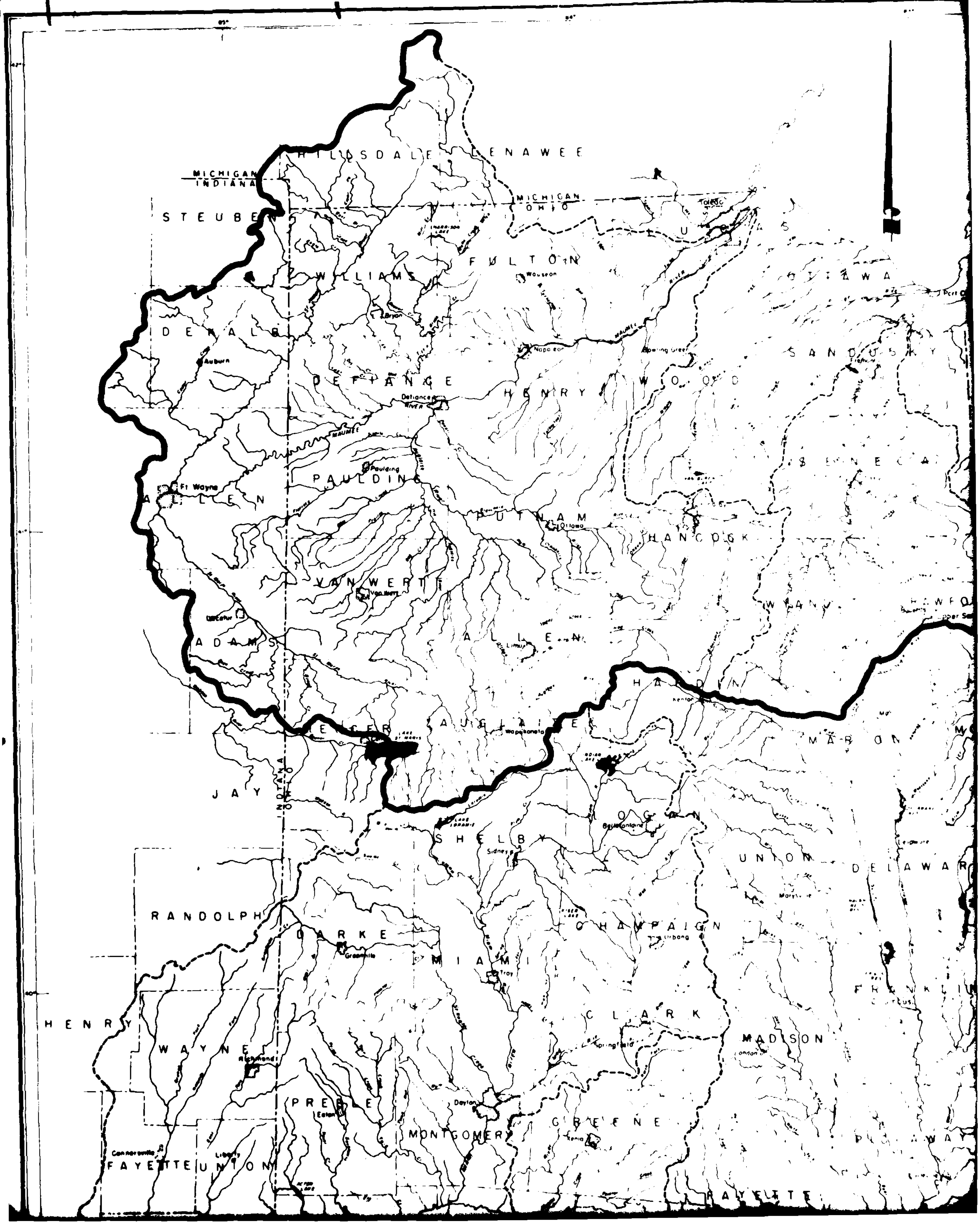
Table XI-1

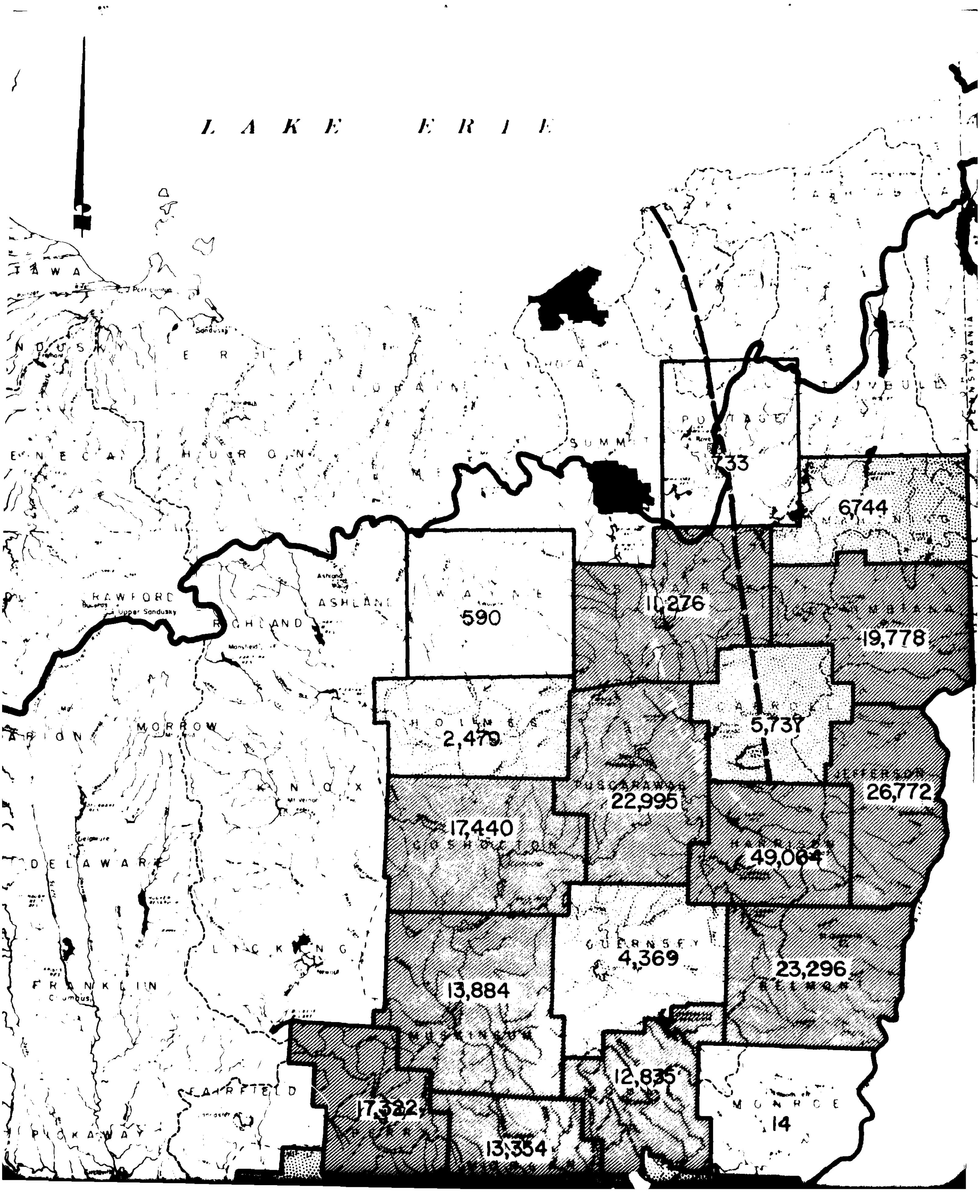
ACREAGE OF STRIP MINED LANDS IN OHIO

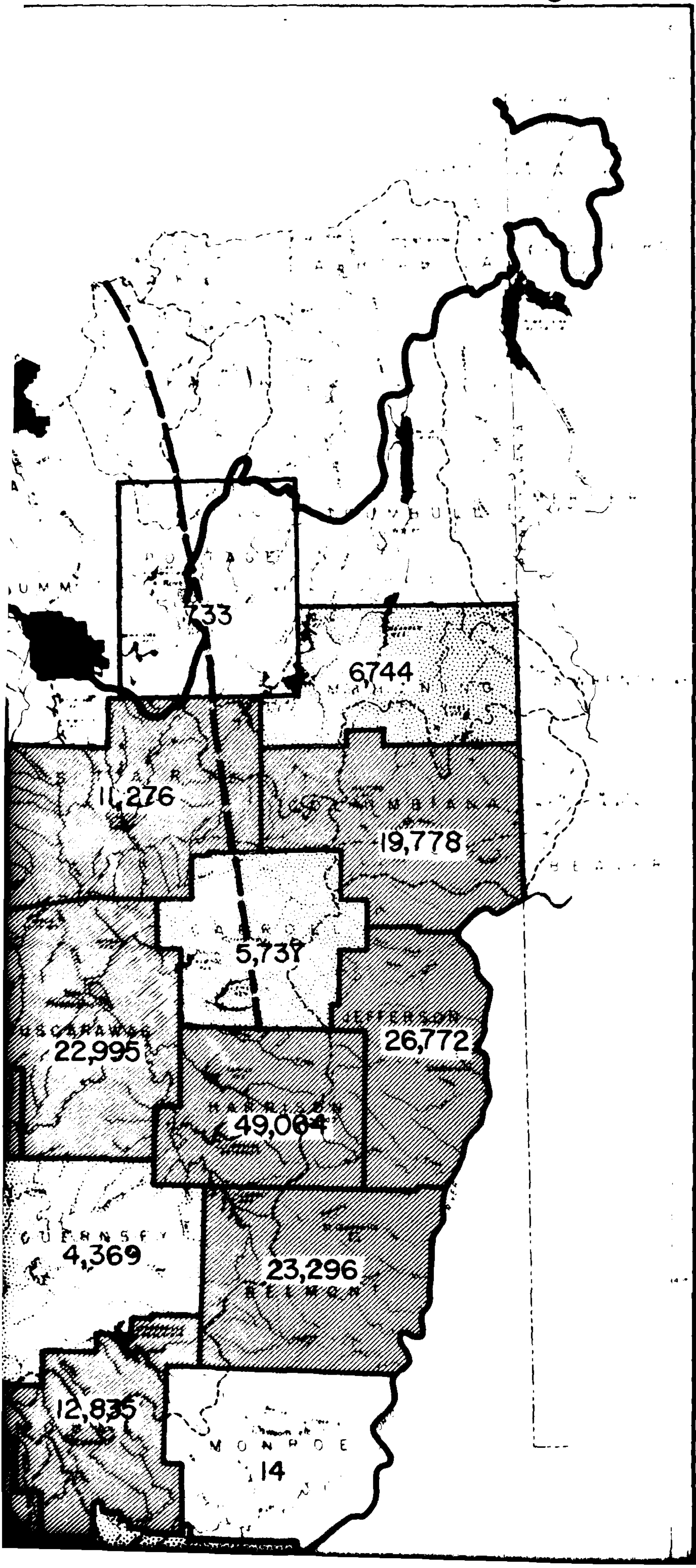
County	Acreage
Athens	2,563
Belmont	23,296
Carroll	5,737
Columbiana	19,778
Coshocton	17,440
Gallia	6,941
Guernsey	4,369
Harrison	49,064
Hocking	3,177
Holmes	2,479
Jackson	6,952
Jefferson	26,772
Lawrence	2,756
Mahoning	6,744
Meigs	5,402
Monroe	14
Morgan	13,354
Muskingum	13,884
Noble	12,835
Perry	17,322
Portage	733
Scioto	148
Stark	11,276
Tuscarawas	22,995
Vinton	4,207
Washington	1,864
Wayne	590

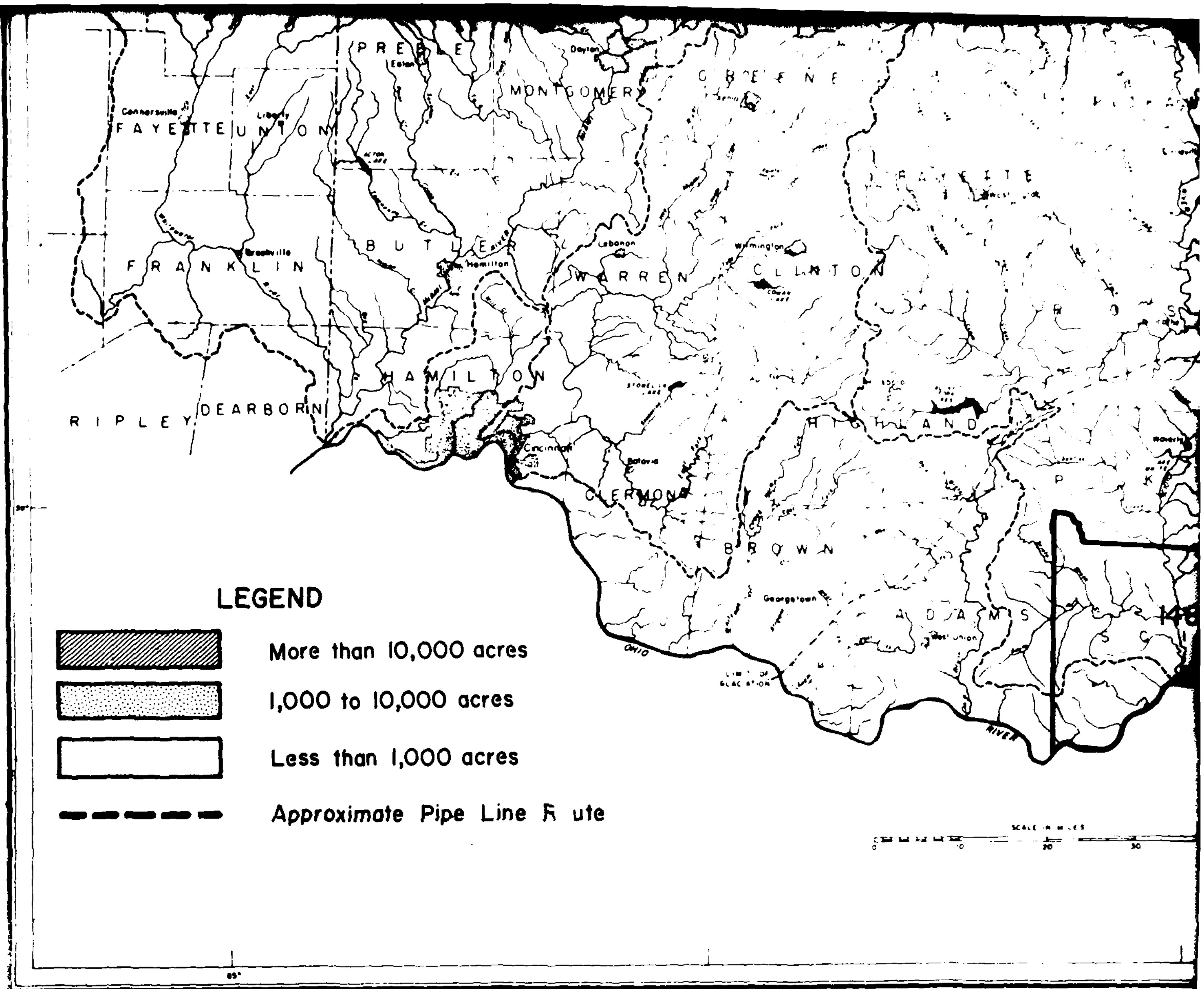
Total 282,692 acres

Less 25% = 210,000 acres

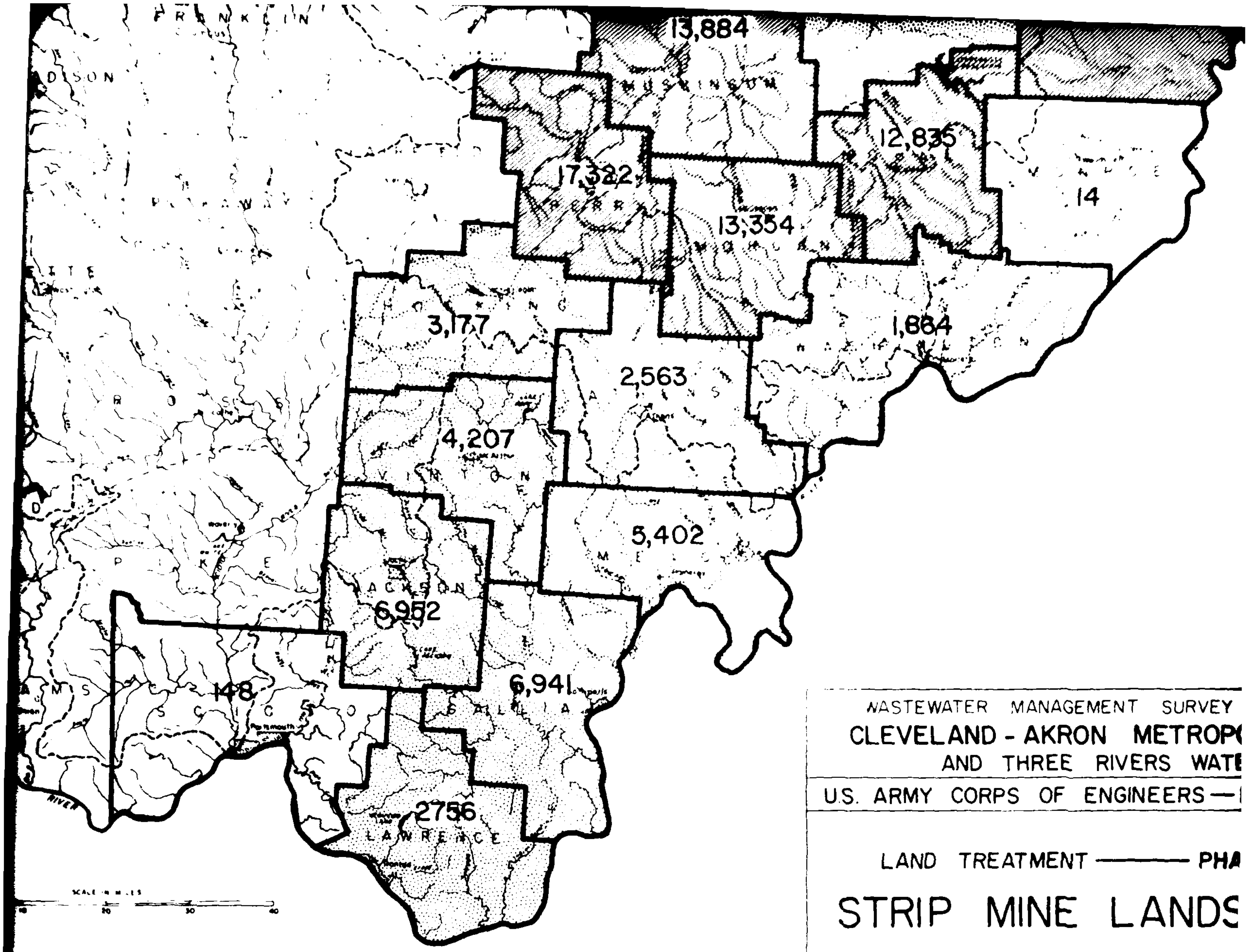

HILLSDALE
LENAWEE
MICHIGAN
INDIANA
MICHIGAN
OHIO
STEUBEN
LUCAS
Toledo
FULTON
WILLIAMS
OTTAWA
Wauseon
Bryan
DEKALB
Auburn
Napoleon
Bowling Green
SANDUSKY
DEFIANCE
HENRY
WOOD
Defiance
MAUMEE
PAULDING
Paulding
SENECA
Ft Wayne
ALLEN
PUTNAM
Ottawa
HANCOCK
VAN WERT
Van Wert
WYANDOT
ADAMS
ALLEN
Lima
HARDIN
Kenton
MERCER
AUGLAIZE
Wapakoneta
MARION
JAY
INDIANA
LOGAN
Bellefontaine
SHELBY
Sidney
UNION
DELAWARE
RANDOLPH
CHAMPAIGN
Urbana
Marysville
DARKE
Greenville
MIAMI
Troy
FRANKLIN
HENRY
CLARK
MADISON
WAYNE
Richmond
Springfield
PREBLE
Eaton
Dayton
GREENE
Xenia
MONTGOMERY
PICKAWAY
Connersville
Liberty
FAYETTE
UNION
FAYETTE


LAKE ERIE
PORTAGE
733
6744
WAYNE
590
11,276
19,778
RAWFORD
Upper Sandusky
RICHLAND
ASHLAND
Mansfield
HOLMES
2,479
5,737
MORROW
KNOX
TUSCARAWAS
22,995
JEFFERSON
26,772
17,440
COSHOCTON
HARRISON
49,064
DELAWARE
GUERNSEY
4,369
23,296
BELMONT
13,884
FRANKLIN
Columbus
12,835
FAIRFIELD
17,322
MONROE
14
13,354


PORTAGE
733
6744
11,276
COLUMBIANA
19,778
5,737
JEFFERSON
26,772
22,995
HARRISON
49,064
GUERNSEY
4,369
23,296
BELMONT
12,835
MONROE
14


PREBLE
MONTGOMERY
GREENE
FAYETTE
UNION
FRANKLIN
BUTLER
WARREN
CLINTON
HAMILTON
RIPLEY
DEARBORN
HIGHLAND
CLERMONT
BROWN
ADAMS
Connersville
Brookville
Hamilton
Lebanon
Wilmington
Cincinnati
Batavia
Georgetown
West Union
OHIO
RIVER
LEGEND
More than 10,000 acres
1,000 to 10,000 acres
Less than 1,000 acres
Approximate Pipe Line R ute

4



WASTEWATER MANAGEMENT SURVEY

CLEVELAND - AKRON METROP

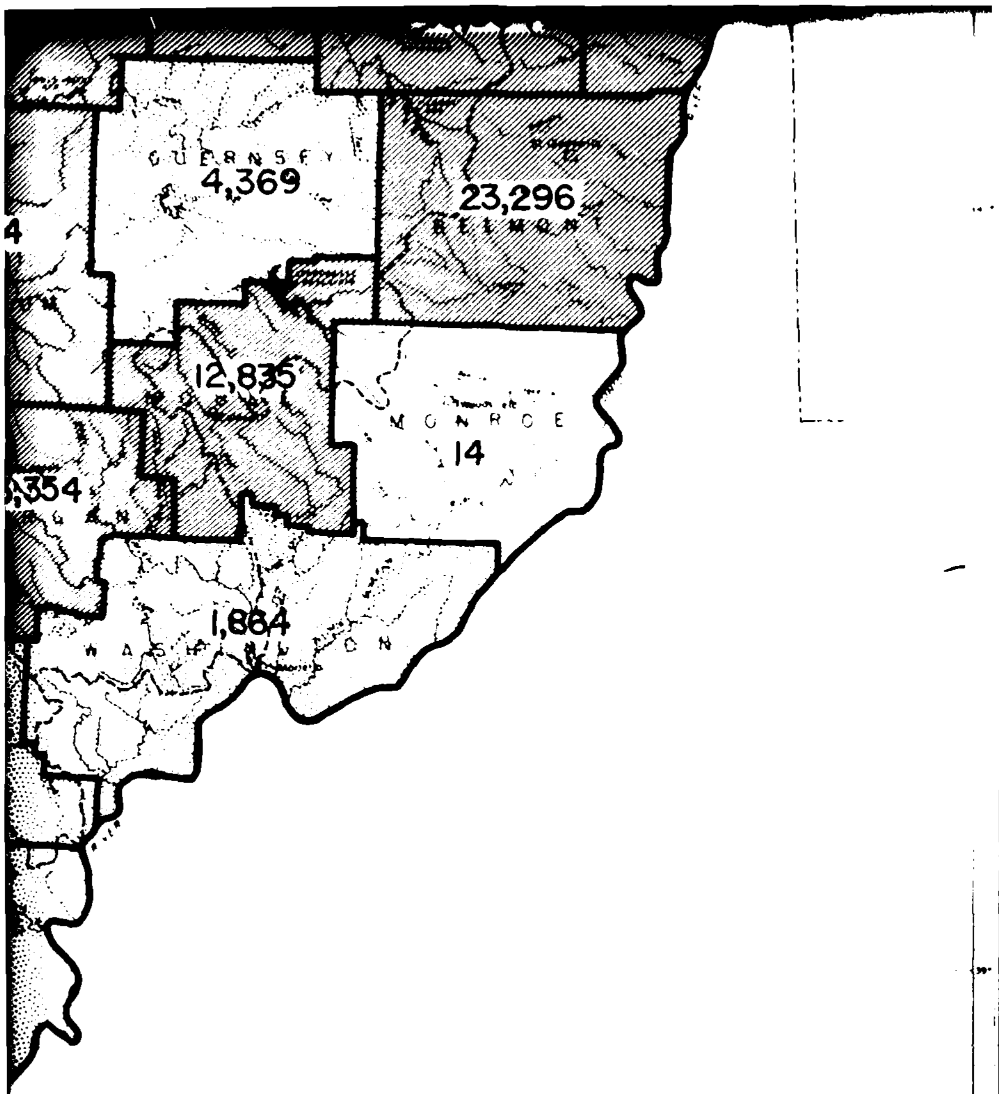
AND THREE RIVERS WAT

U.S. ARMY CORPS OF ENGINEERS —

LAND TREATMENT ——— PHA

STRIP MINE LANDS

15



WASTEWATER MANAGEMENT SURVEY SCOPE STUDY

CLEVELAND - AKRON METROPOLITAN AREA

AND THREE RIVERS WATERSHED

U.S. ARMY CORPS OF ENGINEERS — BUFFALO DISTRICT

LAND TREATMENT ——— PHASE I REPORT

STRIP MINE LANDS IN OHIO

FIGURE XI -1

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CLEVELAND-AKRON METROPOLITAN
AND THREE RIVERS WATERSHED AREA
WASTEWATER MANAGEMENT SURVEY SCOPE STUDY

LAND TREATMENT

PHASE II REPORT

PREPARED

FOR
U. S. ARMY CORPS OF ENGINEERS
BUFFALO DISTRICT

UNDER CONTRACT NO.: DACW49-72-C-0051

WRIGHT-McLAUGHLIN ENGINEERS
ENGINEERING CONSULTANTS
DENVER, COLORADO

DECEMBER 20, 1972

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ATTACHMENTS

SECTION I

INTRODUCTION

The planning and preliminary engineering of the land treatment components of the alternative plans developed during the Cleveland-Akron Metropolitan and Three Rivers Watershed Area Wastewater Management Survey Scope Study are presented in this technical appendix

The descriptions given relate to existing technology and agricultural practices found in various areas of the United States and the world None of the proposed components depends on new technological breakthroughs or future development.

Formerly it had been thought that the only thing new about the consideration of land treatment for the Three Rivers Basin, in terms of engineering, was the application of the technology on a massive scale for a major metropolitan area. However, study of the Melbourne, Australia, sewerage system has demonstrated that this belief was unfounded. Melbourne, Australia, uses land treatment for a population of 1.8 million people on an operating farm of some 27,000 acres. This sewage treatment facility has functioned successfully for more than 70 years.[1]

The layout of the land treatment components described in this appendix is based upon the particular hydrologic, geographic and topographic characteristics of northern Ohio. The results, however, are not far different from those which might be proposed for St. Louis, Detroit, Berlin, or other large metropolitan areas. This, of course, is not surprising because an advanced biological treatment plant in Cleveland would

[1]Due to limited farm size, a portion of the effluent receives only anaerobic/aerobic lagoon treatment before discharge to the bay.

bear considerable resemblance to such plants in other cities

The development of present land treatment technology has included the detailed study and monitoring of three methodologies, which cover the full spectrum of soil types and application techniques.[2, 3] In addition, extremely wide ranges of pollutant loading have been used with consistently good renovation potential being demonstrated under proper management. For instance, the Paris, Texas, effluent loading included a biochemical oxygen demand (BOD) of from 550 to 900 ppm,[4] which is from 25 to 50 times the BOD concentration expected in normal municipal wastewater application. Yet 99 percent reduction in BOD has been experienced with annual application rates of more than 120 inches. At Paris, Texas, the overland flow method is used, which is considered to be the simplest and least sophisticated of the land treatment methods.

The three standard land treatment methods are given below:

Method	Characteristic Soil Type	Typical Soil Permeability Rates	Renovative Capacity
Overland Flow	Very Tight	0.1 in/day	High
Spray Irrigation	Moderate Permeability	2-5 in/day	High
Rapid Infiltration	Very Coarse	24-100 in/day	High

The overland flow method was discovered in Ohio in 1954 by accident by the Campbell Soup Company and used on a 300-acre site there. It is an effective substitute for conventional spray irrigation when the hydrological characteristics of the soil limit the movement of underground water.[4]

Rapid infiltration is practiced at Phoenix, Arizona, at the Flushing Meadows installation where rates of up to 24 inches per day are applied.[5] Spray irrigation was selected as one of six components in the 42+ MGD system designed for Muskegon, Michigan.[6]

The variations in soils and application rates are described here to demonstrate the wide range of conditions under which land treatment is feasible. Logic suggests that between the extreme soil types for which successful land treatment techniques have already been demonstrated, there is a vast number of soil and terrain conditions which can be used with combinations and modifications of the established techniques. Those chosen for the Survey Scope Study only scratch the surface. It is in this context that the reader should review this technical appendix.

Early-action projects, monitoring and research programs will bring to light new methods and refinements, which may be more economical, create greater benefits, and provide even more environmentally sound opportunities.

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SECTION II

TYPICAL PLANS

The land treatment components which are described in the next section of this appendix are parts of an overall wastewater management system. Even though these components are described independently, one must relate each component to the system for proper perspective as to sizing, layout, and function.

The plans containing land treatment have been presented in detail in the Formulation Technical Appendix -- Development of Twelve Alternative Plans.[4] They are as follows:

Plan	Description	Per Cent Land Treatment
2	All Land, State Standards	100
4	All Land, NDCP Standards	100
5	Combination, State Standards	3.0
6	Combination, State Standards	49.4
7	Combination, NDCP Standards	3.2
8	Combination, NDCP Standards	75.5
9	Combination, NDCP Standards	41.5
12	All Land, NDCP Standards	100

To illustrate the roles and relationships of the various components, descriptions of three plans are presented below from the standpoint of land treatment. The other combination plans, which utilize treatment on land to varying degrees, include similar land treatment systems.

PLAN 12

This plan was developed around three basic design options: first,

land treatment of all municipal sewage and (design) storm runoff generated within the Three-Rivers Basin; second, aerated lagoons for secondary treatment prior to application on the land; and, third, the use of "in-basin" land treatment sites to the maximum practical extent, particularly including the treatment of all wastewaters generated by Akron within the Three-Rivers Basin.

The more densely urbanized areas along Lake Erie, where land treatment on a large scale is precluded by existing land use, would be served by collection and transmission facilities to carry the wastewaters to a land treatment site near the junction of Huron, Crawford, and Seneca Counties outside the Three-Rivers Basin. Preliminary treatment* would be given to sewage before it entered the Effluent Transmission Tunnel to the western treatment area, but secondary treatment, winter storage, disinfection, land application of the effluent, drainage of the irrigated lands, and recycling of sludge would all take place at the western area. The region of the Three Rivers Basin to be served in this manner would correspond fairly closely to Cuyahoga County and the portion of Lake County in the lower Rocky River Basin. The wastewaters to be transported to the west would include domestic sewage, compatible (pretreated) industrial wastes, separate storm runoff, and combined sewage from areas with combined sanitary and storm sewers.

The cities and new development which will exist in the upper reaches of the Rocky River, the Cuyahoga River, and the Chagrin River, would have their domestic and industrial wastewaters collected in conventional

*Consisting of screening and aeration.

manner, treated in aerated lagoons, and pumped to storage facilities for detention and subsequent application to irrigated land within the Three-Rivers Basin. The irrigated land would be tiled and the return flow collected for reuse.

Separate storm runoff would be collected, stored in detention basins, and then handled in one of two basic manners. The first method would be to pump from the detention basin directly to a winter storage reservoir, and then to adjacent land treatment areas for final treatment, collection, and reuse. The second method would include detention storage followed by release of the storm runoff at controlled rates into a sanitary sewer system outfall line or sanitary sewage aerated lagoon facility for secondary treatment during off-peak hours, combining the storm water with the domestic/industrial sewage for subsequent storage and land treatment as described above. The stabilized sludge from the aerated lagoons would be recycled to agricultural land situated in the general vicinity of the treatment works.

The wastewaters of the Three-Rivers Basin to be treated on western Ohio agricultural lands would have a system containing the following basic components.

a. A transmission tunnel with underground storage, the tunnel to be gravity flow to its terminus in the western Ohio land treatment area.

b. A pumping plant to lift the sewage out of the tunnel.

c. Aerated lagoons for secondary treatment at the western Ohio site.

d. Large reservoirs sized for winter storage and stabilization.

e. Irrigation land and facilities to apply the wastewater onto the land at controlled rates.

f. A renovation strata in the soil (living filter) where the secondary-treated effluent is given a high degree of treatment.

g. An underground artificial drainage system to collect the percolating waters and provide transportation of this collected water to appropriately selected points for subsequent reuse and/or discharge to surface water streams.

h. Stabilized sludge collection, transportation to appropriate lands for recycling and equipment to apply the sludge to the lands.

i. Pumps, pipelines, upground storage reservoirs, and recreational facilities related to taking advantage of reuse opportunities.

The secondary treatment would take place in biological treatment cells (aerated lagoons) which provide sufficient oxygen and mixing requirements for stabilization of the biochemical oxygen-demanding material in the raw wastewater. The effluent from these treatment cells would be similar in quality to that achieved by conventional secondary treatment.

Effluent from the biological treatment cells would flow to the storage lagoons, where the liquid would be stored for irrigation purposes. Storage lagoons provide flexibility in the system for periods of heavy rainfall or freezing. These storage facilities would provide additional treatment through waste stabilization. Wastewaters would be disinfected by chlorination before irrigation. Irrigation with the

effluent would follow the storage reservoirs. The wastewater and its constituents would be applied to the crops.

The aerobic soil zone provides advanced treatment for the wastewater. Organic matter is decomposed and utilized by the biological community living in the soil; suspended matter is filtered out by the soil particles; nutrients are utilized by the plants or precipitated out by the soil; and viruses are removed by oppositely-charged soil particles and are ultimately biologically decomposed. Significant nitrogen losses occur to the atmosphere.

The percolating water would be collected in pipes and channels, and reclaimed water then transmitted to appropriate points for reuse. The amount of water collected would essentially be that applied by irrigation plus rainfall, less total evapotranspiration.

Sludge Treatment. The sludge in the facultative cells of the aerated lagoon facilities would be removed periodically by specialized pumping equipment. The sludge in western Ohio would initially be applied to non-irrigated Cardington-Bennington soils in the general areas with deep plowing to improve the soil structure. In particular, the clay bulge in the B horizon would be treated with the sludge/deep plowing technique. It is anticipated that about 1,000 acres could be treated per year with the sludge generated in western Ohio land treatment area in the year 2020. However, some lands may be treated more than once, depending on the benefits as determined by further studies. It is anticipated that sludge would be made available to non-irrigated lands

in the vicinity on a pay-for-take basis from time to time once the benefits were fully demonstrated.

For the in-basin lands, the small amount of sludge generated outside of Akron will be applied to adjacent agricultural and open space lands by pressure injection with hauling paid for by the land treatment operator, unless a suitable market can be established for selling the sludge. Costs are based on the former assumption.

The sludge generated in Akron will be applied to lands to be irrigated in the future, but not initially irrigated, at a rate suitable to treat from 300 to 500 acres per year. By the year 2020, the Akron sludge would be used almost exclusively on recreational and non-irrigated farm lands in the Three-Rivers Basin and on agricultural lands adjacent to the land treatment site.

Storm Runoff from Outlying Urban Basins. Outlying basins slated for significant urbanization by the year 2020 will develop in a non-uniform density pattern, ranging from dense urban type clusters, growing incorporated communities, and some very light-density, single-family residences. The latter residences often may be at densities of one unit per one to ten acres.

Land planning and zoning will significantly diminish the present trend to urban sprawl because of the great expense of sewering and generally serving such low-density development, coupled with more stringent leaching field regulations.

Based on the above considerations, it can be assumed that urban storm runoff will be collected and treated from the truly urbanized areas. The light-density residential development of one unit per one to ten acres can be appropriately considered rural in nature, and storm runoff would not be collected and treated.

In cluster areas of development, where typical areas might be 50 to 100 acres in size, with densities of two to twenty units per acre surrounded by open space, storm runoff would be collected and treated locally, utilizing the adjacent open space in accordance with the general philosophy developed by the Chicago Metropolitan Sanitation District, which has been formalized in a regulation tied to issuance of sewer taps.

The storm runoff from the truly urbanized areas would be kept separate from normal stream flow from rural lands.

The "Mini-Border/Open Space" technique[3] would be used for storm runoff treatment in the separate storm water treatment facilities. Akron separate storm runoff would be collected and transported to the Summit County site. Land application would be at 150 inches per year over a forty-week period (280) days.

<u>Storm Runoff from Central Urban Basins</u>. While the urban runoff from outlying, and presently low-development, basins has been reduced from the annual runoff volumes, as presented in Haven & Emerson, Ltd's Phase I Report - Part B[2], the runoff volumes from metropolitan area basins such as in the Akron area (CU-48, 55, 56, 59, 62, 63, 66, 63, 69,

and 70) the Cleveland area, Medina area (R-34 and 35), and Kent (CU-51) have not been reduced from the H & E-computed figures. It is assumed that future development in these metropolitan areas would be sufficiently dense and uniformly distributed to require the collection of runoff from the entire areas. Thus, the full volume of storm runoff as computed is assumed to be collected and treated, even though significant reductions can be realized by institutional/political means.

Plan No. 12 has three patterns of storm water treatment, as follows:

1. Combined Storm Runoff. Detention is provided for release over a three-day period to the municipal sewage collection system during off-peak hours when capacity is available. Additional optimization would be appropriate for detention sizing.

2. Municipal STP-Treated Separate Storm Runoff. Detention is provided for a thirty-day period (0.16 x annual volume) before release to adjacent collector lines for conveyance to the central treatment facility. Here optimization is necessary to reduce detention storage to the one-year storm volume.

3. Separate Storm Runoff. Here, separate storm water facilities are provided. Storage in the basin is provided for the one-year design storm volume to be evacuated within three days to the winter storage reservoir prior to land treatment. There is no microstraining or other PCT plant-type treatment between detention and winter storage as with previous land treatment plans. The storm runoff designated as the average annual volume is fully treated in all instances.

Bottom deposits in the detention reservoirs would be treated as a "resource out of place" and provided at no charge to public and private interests for top soil and landfill purposes.

Combined Sewer Systems. There are many combined sewer overflows which discharge to the Cuyahoga River, Rocky River, and Lake Erie, which are significant sources of pollution. These overflows would be collected and stored at strategic locations in mined underground or covered surface storage for release at a selected rate into the combined sewer system or into new outfall lines to the transmission tunnel.

Low-Flow Augmentation. The total return flow from the western Ohio land treatment management areas would be of a large magnitude for the irrigation period. Depending upon the extent of reuse and transportation, this return flow would be distributed over numerous streams, primarily in the upper Huron and Sandusky River basins. Upground reservoirs may be provided where needed to equate supply to low-flow periods in the streams. Numerous recreational opportunities exist to be developed in conjunction with this reuse, including fishing, boating, swimming, and hunting. Wildlife refuge and bird habitats would also be included. Water supply potential for communities and industry would be enhanced.

Within the Three-Rivers Basin, the return flow from land treatment areas will beneficially raise the low flows of the upper Cuyahoga and the upper Rocky River.

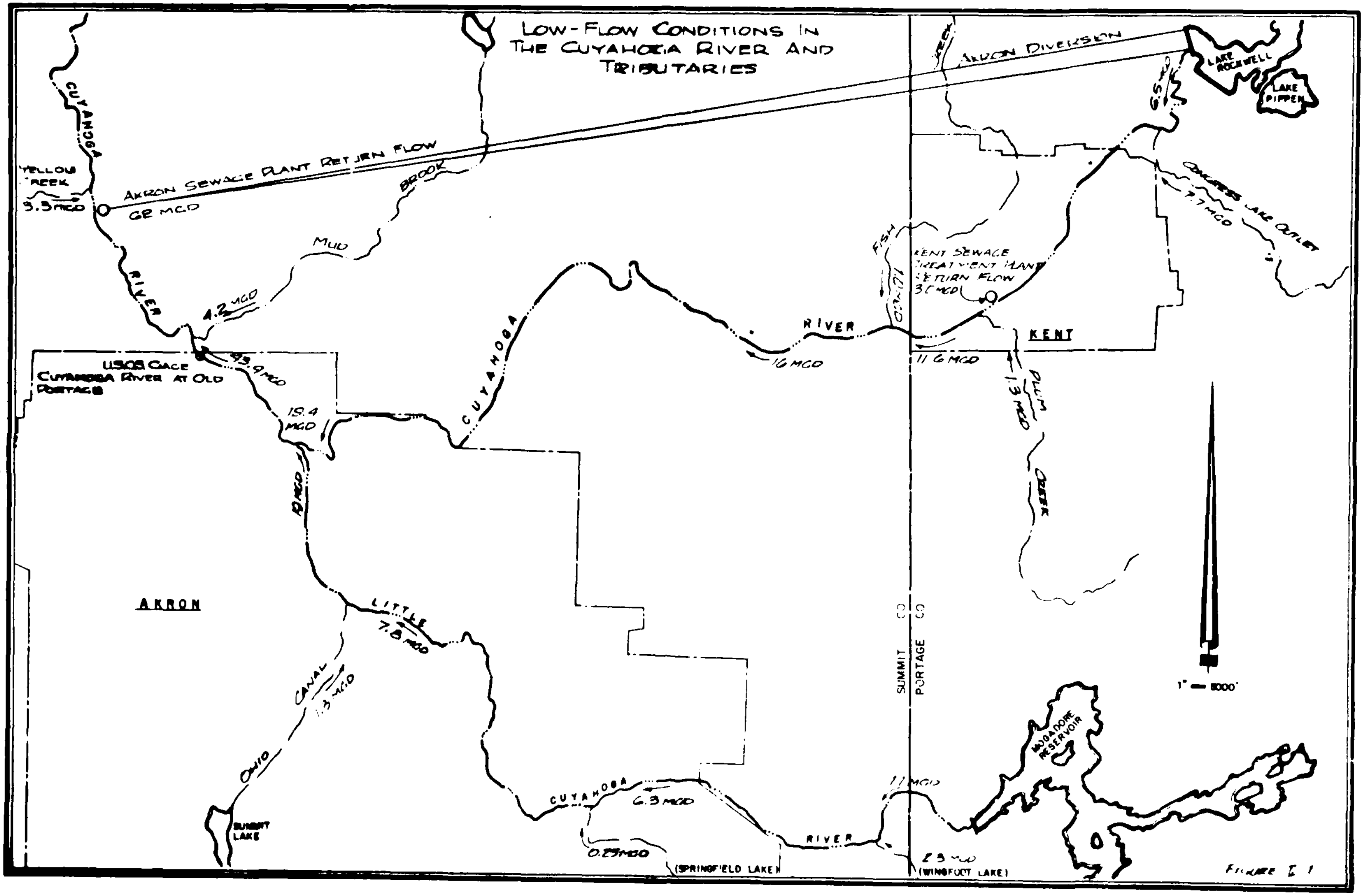
Low-Flow Aspects of the Cuyahoga River below Lake Rockwell -- Present Conditions. At present, the mainstem of the Cuyahoga River is subject to very low flows along the twenty-mile reach between Akron's principal water supply diversion at Lake Rockwell and the discharge point for the Akron Sewage Treatment Plant near the confluence of Yellow Creek with

the Cuyahoga River. Any sewage treatment plan which would affect either quantities or points of water withdrawal or return must give careful consideration to the effect upon the low-flow river regime within this critical reach.

The low-flow data are presented in map form in Figure No. II-1, attached. The basic source of these data was the Map Supplement to the Water Inventory of the Cuyahoga and Chagrin River Basins, published in 1959 by the Ohio Department of Natural Resources, Division of Water.[5] These data have, however, been updated to 1967 or 1968 in most cases, using a report prepared by H & E for the Three-Rivers Watershed District.[6]

Figure No. II-2 presents a low-flow profile of the mainstem of the Cuyahoga River from Lake Rockwell to its mouth. The reach of the river shown in Figure No. II-1 is indicated on the profile. This profile should be regarded as only illustrative of the general proportions of low-flow conditions and, in particular, of the impact of Akron's water supply and sewage facilities, but the absolute rates of discharge given should not be accepted as sufficiently defining particular low-flow problems.

The base flow or natural sustained dry-weather flow in the Cuyahoga below Lake Rockwell is relatively high for the size of the drainage basin as compared with other rivers in the Lake Erie Basin. This is due primarily to ground water discharge from extensive terrace deposits above Hiram and from highly permeable kames and kame terraces



LOW-FLOW CONDITIONS IN THE CUYAHOGA RIVER AND TRIBUTARIES
CUYAHOGA
YELLOW CREEK
3.3 MGD
AKRON SEWAGE PLANT RETURN FLOW
62 MGD
BROOK
MUD
RIVER
4.2 MGD
USGS GAGE CUYAHOGA RIVER AT OLD PORTAGE
43.9 MGD
19.4 MGD
AKRON
LITTLE
7.8 MGD
CANAL
1.3 MGD
OHIO
SUMMIT LAKE
CUYAHOGA
RIVER
16 MGD
FISH
1.0 MGD
KENT SEWAGE TREATMENT PLANT RETURN FLOW 3.0 MGD
11.6 MGD
KENT
PLUM
1.3 MGD
CREEK
AKRON DIVERSION
CREEK
6.5 MGD
LAKE ROCKWELL
LAKE PIPPEN
7.7 MGD
CONGRESS LAKE OUTLET
SUMMIT CO
PORTAGE CO
1" = 5000'
CUYAHOGA
6.3 MGD
0.23 MGD
(SPRINGFIELD LAKE)
RIVER
11 MGD
2.3 MGD
(WINGFOOT LAKE)
MOGADORE RESERVOIR
FIGURE I 1

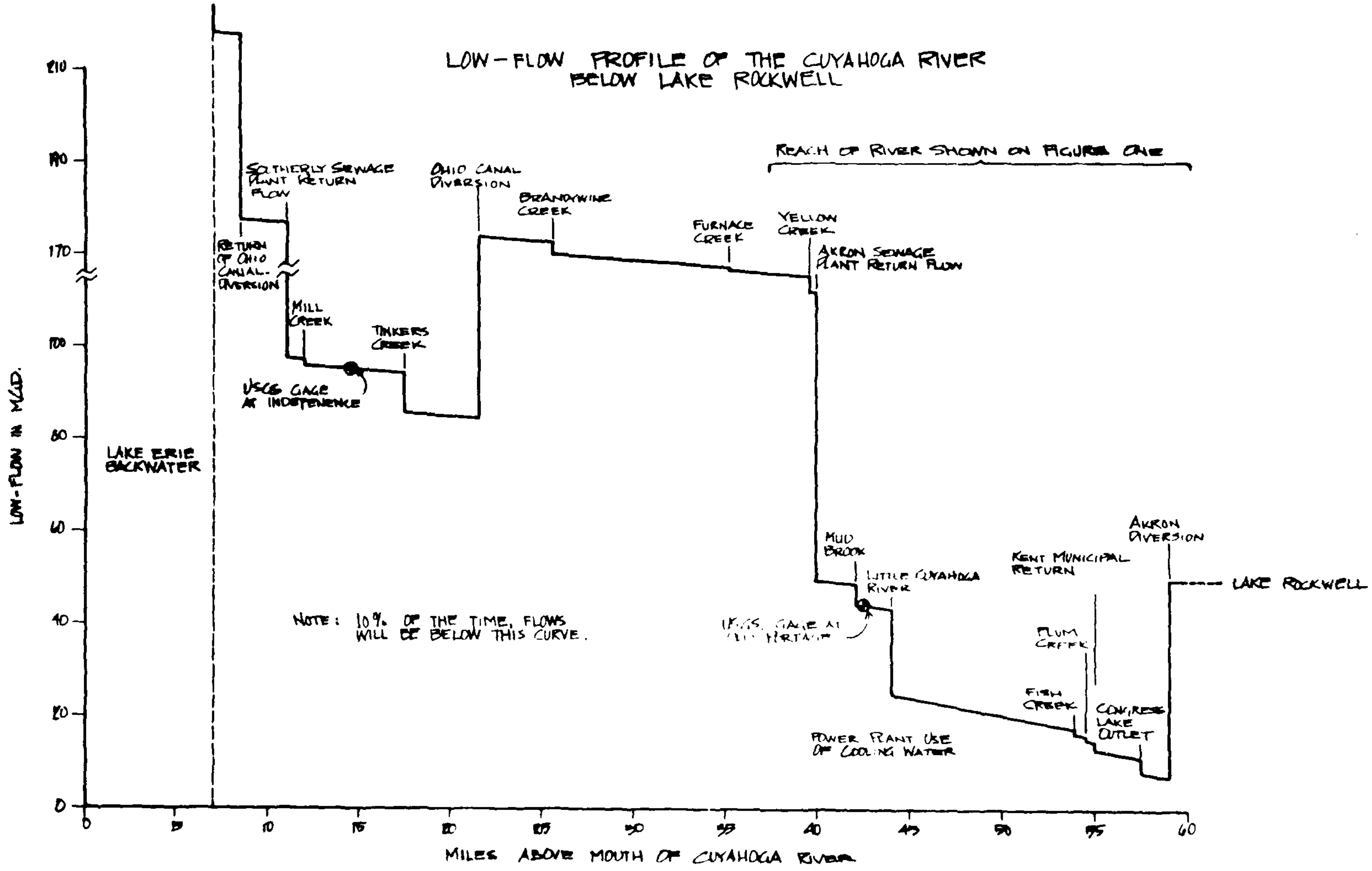

LOW-FLOW PROFILE OF THE CUYAHOGA RIVER
BELOW LAKE ROCKWELL
REACH OF RIVER SHOWN ON FIGURE ONE
LOW-FLOW IN M.G.D.
MILES ABOVE MOUTH OF CUYAHOGA RIVER
0
10
20
40
60
80
100
170
190
210
0
5
10
15
20
25
30
35
40
45
50
55
60
LAKE ERIE BACKWATER
RETURN OF OHIO CANAL DIVERSION
SOUTHERLY SEWAGE PLANT RETURN FLOW
MILL CREEK
USGS GAGE AT INDEPENDENCE
TINKERS CREEK
OHIO CANAL DIVERSION
BRANDYWINE CREEK
FURNACE CREEK
YELLOW CREEK
AKRON SEWAGE PLANT RETURN FLOW
MUD BROOK
LITTLE CUYAHOGA RIVER
KENT MUNICIPAL RETURN
PLUM CREEK
FISH CREEK
CONGRESS LAKE OUTLET
AKRON DIVERSION
LAKE ROCKWELL
POWER PLANT USE OF COOLING WATER
NOTE: 10% OF THE TIME, FLOWS WILL BE BELOW THIS CURVE.

FIGURE II-2

drained by the Congress Lake Outlet.[7] This reach of the river, however, is now entirely regulated by upstream reservoirs and the diversion for Akron's water supply.

On frequent occasions, the withdrawal of water at Lake Rockwell curtails the passing of any water downstream, and the only flow in the river immediately below the dam is due to drainage from Twin Lakes, seepage from the reservoir, and the intermittent discharge of filter backwash water from the Akron intake, which may be operated from three to twenty times per day. During July and August of 1971, 28.6 and 32.3 million gallons, respectively, were relased from the backwash operation, giving an average of approximately one MGD flow from this source. In addition, effluent discharge from the new Twin Lakes Sewage Treatment Plant will shortly be contributing to the flow of the Cuyahoga at Ravenna Road a short distance below the dam.

Low-Flow Aspects of the Cuyahoga River -- Future Conditions. Increased water diversions by the City of Akron in the future will further deplete the flows of the Cuyahoga River. Thus, low-flow conditions in the reach of the river between Lake Rockwell and Yellow Creek, assuming that the current water management practices continue, will worsen.

Wastewater management in the Cuyahoga Basin needs to consider the ramifications of water supply to some extent, and comprehensive planning should incorporate all phases of water management and the hydrologic cycle.

Return flow of treated effluent upstream from Lake Rockwell will not improve low-flow conditions in the Cuyahoga River if Akron were to take the increased flows into its municipal water system as an additional supply. An agreement with Akron may be needed to forestall the diversion of new water intended for recreational purposes.

Non-Structural Means of Wastewater Management. Hand-in-hand with the physical works proposed in Plan 12 for wastewater management, non-structural measures would be employed. These include, but are not limited to, the following:

1. Roof-top ponding ordinances for Cleveland and Akron for storm runoff.

2. Flood plain regulation, basin-wide.

3. Upstream ponding regulations for new developments and urban renewal, including the "blue-green" technique of the Department of Housing and Urban Development.1

4. Cooling water recycling for power plants and industry.

5. Street cleaning ordinances and resolutions.

6. Reduction of use of de-icing chemicals.

7. Development of area-wide regulations on solid waste disposal management.

8. Land use regulations to limit and control unplanned urban sprawl.

9. Agricultural regulations related to winter fertilizer applications on frozen ground.

In general, the volumes of storm runoff which have been computed for the years 2020 and 1990 are high considering the likelihood of an

effective upstream ponding regulation being enacted within the next five years in the Three-Rivers Basin. Techniques of building and land development are available to reduce peak runoff to pre-development rates for the one-year frequency. Such ordinances are being adopted elsewhere with varying degrees of restrictiveness.

PLAN 4

This plan is similar to Plan 12 in that it proposes land treatment for all of the wastewaters, excepting particular industrial wastes, generated within the Three-Rivers Basin. Plan 4, however, differs from Plan 12 in the following respects: first, all secondary treatment would take place in activated sludge plants within the Three-Rivers Basin; second, to the maximum practical extent, sludges would be collected and piped to an area south of the Basin for reclamation of strip-mined lands; and, third, the secondary-treated effluent from a much larger area, including Akron, would be transported to the western Ohio land treatment area via the Effluent Transmission Tunnel.

In Plan 4, 87.2 per cent of the estimated flow of municipal sewage from the whole Three-Rivers Basin in the year 2020 would be transported to the western Ohio land treatment area. In addition, more than half of the storm water runoff which is projected to require treatment in 2020 would go to the western area. Detention storage would be provided in the basins-of-origin for this storm runoff with capacities of either 16 per cent of the annual runoff volume for separately storm-sewered areas, or equivalent to the one-year frequency

storm volume for combined storm/sanitary sewer systems. The stormwater would then be released at controlled rates to the secondary biological treatment plants, which, in turn, discharge to the Effluent Transmission Tunnel (E.T.T.).

These secondary treatment plants would discharge digested sludge through a network of pipelines to the strip-mined area in southeastern Ohio. The treated effluent from the plants would in most cases be dropped directly into the Effluent Transmission Tunnel, which traverses the Lake Erie shoreline, or into the southern spur tunnel, which extends from the E.T.T. up the Cuyahoga valley to the Akron treatment plant. In some cases, pump stations and short force mains would be needed to transport the plant effluent to a drop shaft into the E.T.T.

Once in the tunnel, the treated storm, sanitary, and compatible industrial wastewaters would flow by gravity to the terminus of the tunnel near the winter storage reservoir at the junction of Seneca, Crawford, and Huron Counties. A lift shaft and pumping plant at the lower end of the tunnel would raise the effluent to ground level. Operation of the winter storage reservoir and land treatment system would be similar to Plan 12.

In the upper reaches of the Three-Rivers Basin, where opportunities for land treatment are locally available, municipal sewage would be collected and given secondary treatment at 25 biological treatment plants before being pumped to storage reservoirs at the nearest land treatment s tes. Sludge from these plants would be transported by

pipeline for strip-mined land reclamation where proximity to the trunk pipeline makes this practice feasible. Otherwise, sludge would be disposed of on adjacent agricultural lands within the Three-Rivers Basin.

Of the 77 storm runoff sub-basins which are not tributary to the E.T.T., 35 would be treated by releasing the storm water from detention storage basins to municipal sewage treatment plantsand thence to winter storage and land treatment within the Three-Rivers Basin. The remaining 42 sub-basins would be given screening and sedimentation and then pumped directly to separate winter storage reservoirs prior to disinfection and land treatment at higher application rates appropriate to the quality of the storm runoff.

PLAN 7

The overall wastewater management system proposed in this plan would make selective use of land treatment sub-systems for the smaller communities in the upper reaches of the Rocky, Cuyahoga, and Chagrin River basins. Sixteen municipal sewage treatment plants would provide secondary biological treatment prior to winter storage, disinfection, and application to nearby agricultural lands. Sludge from these plants would usually be applied to agricultural lands, although in two cases proximity to the main pipeline to the strip-mined area would make strip-mine reclamation the preferred means of sludge management.

Several of these sixteen municipal plants would be used for treatment of stormwater released from nearby detention storage reservoirs during periods of off-peak sanitary flows. This routing of stormwater

would be used in cases where the economic advantage lay with dual use of the treatment, transmission, and storage facilities provided for the municipal sewage. In addition, nine separate stormwater treatment plants, consisting of screening and sedimentation at the detention storage facilities, are proposed prior to direct transmission of the stormwater to winter storage reservoirs for subsequent disinfection and land treatment. These separate land treatment systems for storm runoff have been proposed to realize the joint benefits of lower transmission costs where municipal sewage treatment plants are distant, and of low-flow augmentation where the local availability of land treatment sites makes it possible to keep the renovated return flows high in the basins of origin. Bottom deposits from the separate stormwater detention storage reservoirs would be removed periodically with conventional machinery and made available for topsoil and landfill purposes.

The land treatment systems proposed in Plan 7 represent the simplest and most limited applications of this method. The components required are on a small scale, widely dispersed, and include only minor transmission facilities on or near the ground surface.

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SECTION III

SCHEMATIC DESIGN OF LAND TREATMENT COMPONENTS

INTRODUCTION

This section contains a discussion of the design considerations for each component of the land treatment systems, whose overall relationships were described in the preceding section. The discussion of each component outlines the preliminary schematic design developed as a basis for cost estimates of the twelve alternative plans.

Each component of the system is discussed in the sequence in which it occurs as the wastewater being treated moves from its point of generation through pre-treatment in either conventional secondary sewage treatment plants or aerated lagoons on to a storage reservoir, and ultimately to the land treatment site. It will be noted that several of the components, such as force mains and pumping plants, are utilized at more than one place in the sequence. In the case of pumping plants, there is a variation in the actual type of plant used at a particular point in the sequence of components.

Sketches showing details of some of the components have been included. The basic planning components of the land treatment system are listed briefly below.

1. Secondary Treatment Facilities. (Prior to land application for tertiary treatment)

    A. Using conventional sewage treatment plants

    B. Using aerated lagoons.

2. Transmission Facilities.

   A. Pumping plant (where force main to tunnel is required).

   B. Force main and/or drop shaft and tunnel.

   C. Lift station secondary pumping plant at tunnel lift shaft.

   D. Force main to storage reservoir.

3. Storage Reservoir.

   A. Reservoir for winter storage.

   B. Reservoir aeration.

   C. Disinfection.

4. Land Treatment Site.

5. Irrigation System

   A. Pumping plant.

   B. Force mains.

   C. Application equipment and distribution piping.

6. Drainage System.

   A. Artificial subsurface drainage.

   B. Conduits and/or canals.

7. Sludge Management Facilities.

8. Miscellaneous (Monitoring, administration buildings, laboratories).

The components vary for each particular installation in this study; however, the basic functions and layout follow a pattern and have enough similarity so that the following component descriptions are generally applicable.

PUMPING PLANTS

Design and Location. Several types of pumping plants are utilized in connection with moving either treated effluent or raw sewage from conventional sewage treatment plants or collection points to successive treatment component process points enroute to final land treatment.

Conventional-type centrifugal pumping plants are utilized at the upstream ends of force mains to move the treated effluent into the tunnel or out to local storage facilities in-basin, as the case may be. To move raw sewage, a centrifugal, sewage/trash-type pump is utilized.

To move effluent or raw sewage out of the tunnel at its terminus, another type of vertical pump must be utilized to effect the lift to the surface. Here again, there are two types of pumping arrangements, one for effluent and the other for raw sewage, both with total lifts of up to 700 feet.

For the treated effluent, the tunnel would terminate in a concrete-lined basin at the elevation of the tunnel. Vertical turbine pumps would be placed in a lift shaft, or shafts, directly over the reservoir and used to lift the effluent to the surface and into the nearby storage reservoir. Another possibility would be to drill a series of wells through the top of the tunnel near its terminus at well-spaced intervals and to lift the effluent to the surface directly from the tunnel and thence into the nearby storage reservoir. The former was priced.

For the raw sewage, the tunnel would end in a concrete-lined clear well. From the clear well, suction pipes would take the raw sewage to

an underground dry well-type pumping plant. The pumps would be horizontal, centrifugal, sewage/trash-type and would pump the raw sewage to the aerated lagoons on the surface close to the tunnel terminus.

For finally pumping effluent from the storage reservoirs to the irrigation equipment which applies it to the land, a relatively low-head vertical turbine-type pump is utilized.

Construction. The physical facilities for housing the pumps for the latter type of service would be of typical farm-use design, and, in many cases, the entire facility would be pre-fabricated. The pumping plant at the tunnel terminus or the pumping plants feeding effluent or raw sewage through force mains into the tunnel, or those pumping directly from collection points or secondary treatment plants to in-basin land treatment storage reservoirs, would be of conventional sewerage industry design and construction.

TRANSMISSION TUNNEL, DROP AND LIFT SHAFTS

Design. The design of the tunnel portion of the conveyance system to the western land treatment site is based on projected 2020 total stormwater and municipal flows. The construction of two smaller tunnels, time-phased, may be selected in lieu of one larger tunnel. The tunnel is fully lined.

The tunnel has been sized to handle the cumulative peak sanitary flows from the various treatment plants connected to it; that is, about twice the average daily flow. Sufficient capacity is thus provided to absorb the daily maximum stormwater flows which may be anticipated under the stormwater flow design criteria.

For main lines feeding into the tunnel proper from several treatment plants not directly on the tunnel route or beyond the starting point of the tunnel, force mains and pumping stations were utilized. In these cases, gravity-flow mains appeared uneconomical due to depth of excavation required for proper gradients.

Routing (As in Plan 12 for discussion purposes.) The tunnel starts at the Euclid Treatment Plant where raw sewage, after having received preliminary treatment, is routed by drop shaft into the tunnel. The flow, via force main, from the Willoughby-Eastlake Treatment Plant also enters the tunnel through the Euclid drop shaft. Following preliminary treatment, the flow from six other shoreline plants successively enters the tunnel route as it proceeds in a southwesterly direction toward the western Ohio land treatment area. The flow from the last three plants (Lakewood, Rocky River, North Olmsted) served by the tunnel is delivered through individual force mains to drop shafts into the tunnel, as in the case of Willoughby-Eastlake. See Figure III-1.

The tunnel, having collected the flows from the eight shoreline plants, then goes directly to the site of the large aerated lagoon complex which is centrally located within the western Ohio land treatment area. During the course of accumulating flows from the various plants along its route, the tunnel increases in size from an initial diameter of eight feet to a diameter of eighteen feet at the point where a twelve-foot diameter stub tunnel from the Southerly Treatment Plant enters the main tunnel route. The eighteen-foot diameter then continues

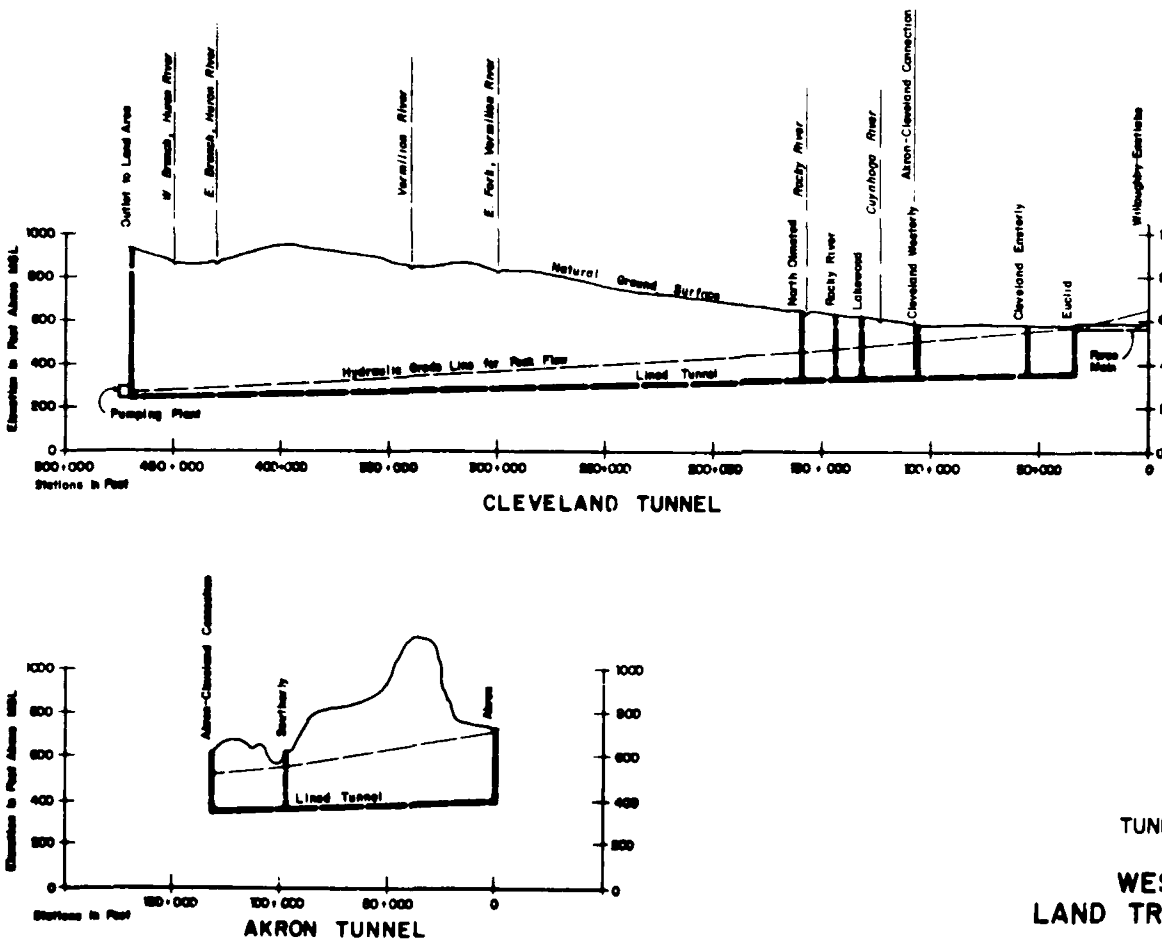


Figure III-1
TUNNEL PROFILES
TO
WESTERN OHIO
LAND TREATMENT AREAS

to the western terminal point of the tunnel, as described above. At this point, the effluent is pumped out of the tunnel through a lift shaft.

Appurtenances. The force mains, drop shafts, and lift shafts appurtenant to the tunnel proper have already been mentioned in the discussion above. Aeration is provided in the tunnel at ten-mile stations.*

Final ingress of effluent to the tunnel is by means of a series of drop shafts sized to satisfy the flow requirements from the various treatment plants being served by the tunnel. Where plants are located in close proximity to the tunnel, flows can usually go directly into a drop shaft over the tunnel. Where plants are at some distance from the tunnel, it is then necessary to introduce the use of a force main through which the effluent from the treatment plant is pumped to a drop shaft located at the tunnel.

Construction. The tunnel construction would commence at a series of shafts so spaced along the alignment as to afford access to that number of work crews deemed essential for the completion of the tunnel within a reasonable length of time. One such possibility would be twenty-mile spacing of shafts, which would allow access for eight crews, each pair working simultaneously toward a meeting point ten miles distant. Once the access shafts had been driven to the required subterrannean elevations, actual excavation of the tunnel could be accomplished, using either conventional mining methods or by the use of mechanical moles. Some of the construction access shafts would revert

*For Plans 9 and 12 only.

to future-use aeration or drop shafts for the wastewater effluent or raw sewage to be conveyed, depending upon the sequence of the treatment method ultimately selected.

The tunnel affords gravity flow and can be surcharged if desired by means of underground storage chambers strategically located at points close to and at a higher elevation than the tunnel itself. The force mains referred to are pipelines under pressure located in available rights-of-way, either above ground or just below ground, following the general contour of the ground to be as inconspicuous as possible, consistent with engineering design requirements.

Construction Timing. Due to the magnitude of any construction effort necessary to install transmission tunnels of varying sizes, it is essential that the chronological date at which time a "no discharge of critical pollutants" or other wastewater standard is to be achieved, be compared with the lead-time required for construction of the tunnel facility. A preliminary analysis has indicated that a four-year lead-time would be required to construct a large diameter tunnel for a distance of some eighty miles, as is contemplated in at least one of the wastewater management plans now formulated.

This construction lead-time period will have a direct bearing on any phasing decisions to be made regarding phasing out of present treatment facilities, as well as the timing for bringing on-line new facilities designed to meet the higher effluent treatment standards.

STORAGE RESERVOIRS

Design. Storage reservoirs, required primarily for winter storage of effluent in the land treatment system, actually serve a three-fold purpose. The system must provide storage capacity for the treated effluent which continues to be generated between irrigation seasons when it cannot be utilized effectively. This storage capacity enables the reservoir to serve a second purpose as an equalizing reservoir should any situations arise during the growing season which restrict the flow of effluent for short periods of time. The third purpose served by the reservoirs is the further removal of suspended solids and reduction of BOD, thereby polishing the effluent prior to its final treatment on the land.

The reservoirs are designed as earth embankment structures, rip-rapped as needed, with concrete inlet and outlet structures, access roads, and fencing. Sites with relatively impervious sub-soil were preferred, in order to minimize the need for any lining of the reservoirs.

Construction. The volume of earth needed for the embankment is to be borrowed from the interior of the reservoir area. Dependent upon topography and availability of land area, storage facilities inside the Three-Rivers Basin area may be constructed in natural depressions or off-stream channels.

Location. The reservoirs are usually centrally located within the land treatment areas which they serve, in order to optimize piping and pumping

layouts, especially when large land areas are involved. For smaller areas inside the Three-Rivers Basin, the reservoir may be located at the periphery of the land area or close to the secondary treatment plants or aerated lagoon treatment facilities, depending upon the type of secondary treatment utilized prior to final land treatment.

LAND TREATMENT SITE

Size and Location. The size and the location of the land treatment site selected for use in the sequence of components comprising the land treatment system are interrelated variables. A comprehensive review of the necessary data presenting the parameters which relate to the suitability of a particular soil association for use in land treatment must first be undertaken. Once a soil association has been identified as having the necessary qualities suited to use for land treatment, it must also exist in sufficient acreage to support the treatment of the particular volume of wastewater ultimately to be generated in the immediate vicinity. Should this not be the case and land treatment is still desired, the wastewater will then have to be transmitted to another geographic location where land of suitable quality, and in sufficient acreage, does exist. Thus, the need arose, in several of the plans formulated for the study area, to transport the wastewater generated by the Lake Erie shoreline plants to a western Ohio land treatment area.

Special Considerations. Having generally located a suitable land treatment area geographically, the existing and projected land use must be considered. The net area available for land treatment must then be

determined, and it is this net area which must be able to support a selected wastewater application rate based on a number of parameters, including the average rainfall in the area under consideration.

It was generally observed that about 70 per cent of the rural land area comprising a particular land treatment area is usable for land treatment under the condition that existing residents and features are not relocated. Of the net area designated for land treatment purposes, it is estimated that 92 per cent will actually be irrigated, based on typical private farm operations in the west.

The land finally designated must then be acquired in fee simple, or some other acceptable arrangement must be made for its use for the intended purpose. The inhabitants of the land may or may not all have to be relocated, as the next step in the site preparation process, depending upon the configurations chosen for the irrigation system equipment and method of application of the nutrient-enriched wastewater.

The final step involving actual physical preparation of the site would now take place. This could include tree removal, grading, and installation of access roads. The land would then be ready for installation of the irrigation system component described in the next section.

IRRIGATION SYSTEM

Description of Equipment, Design, and Operating Sequence. Once the necessary land area suitable for land treatment by irrigation methods has been located and the right to its use acquired through a satisfactory method,* the irrigation system equipment and distribution piping would

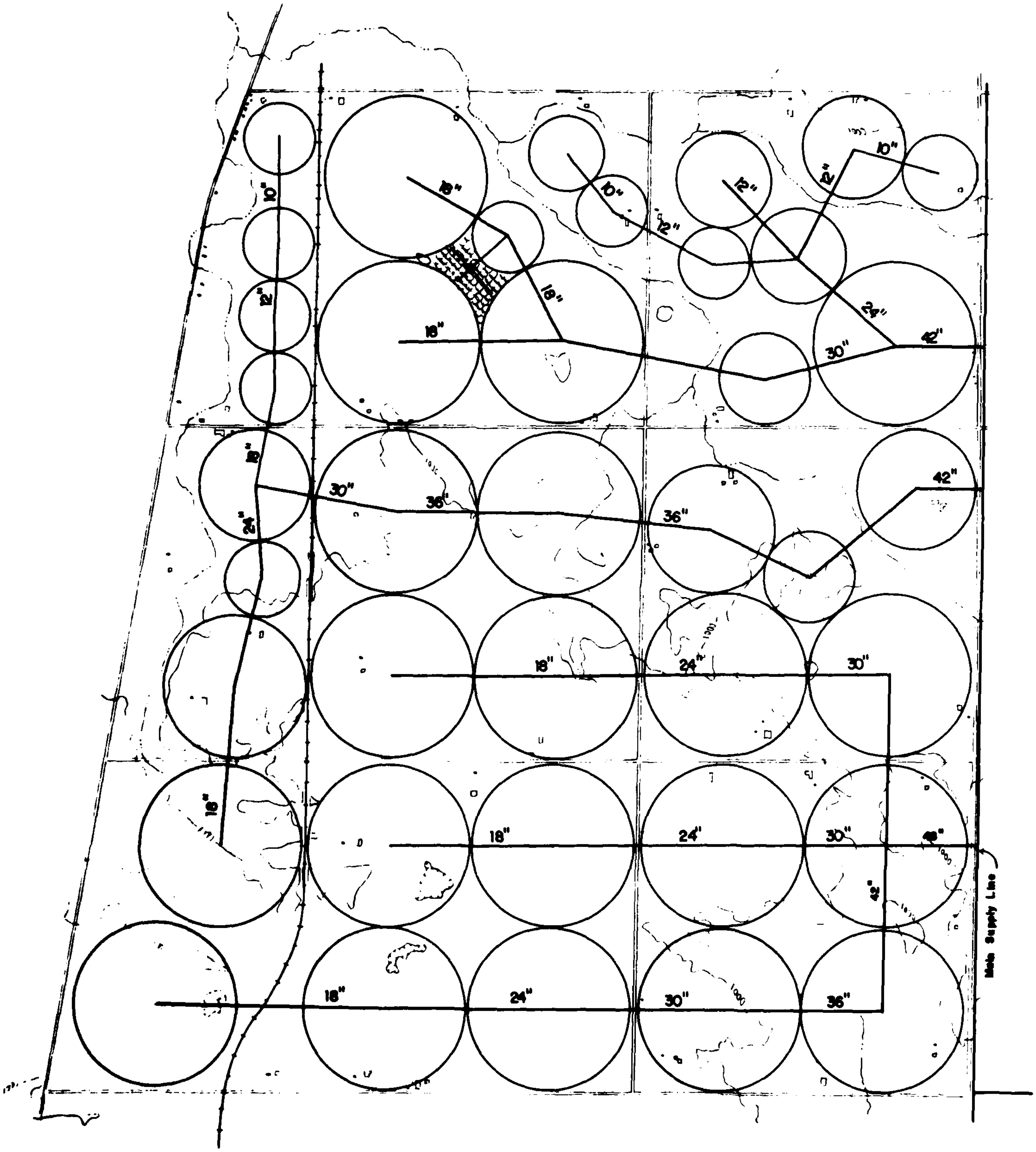
*Long-term lease, fee simple acquisition, or some combination, dependent upon institutional analyses.

be installed.

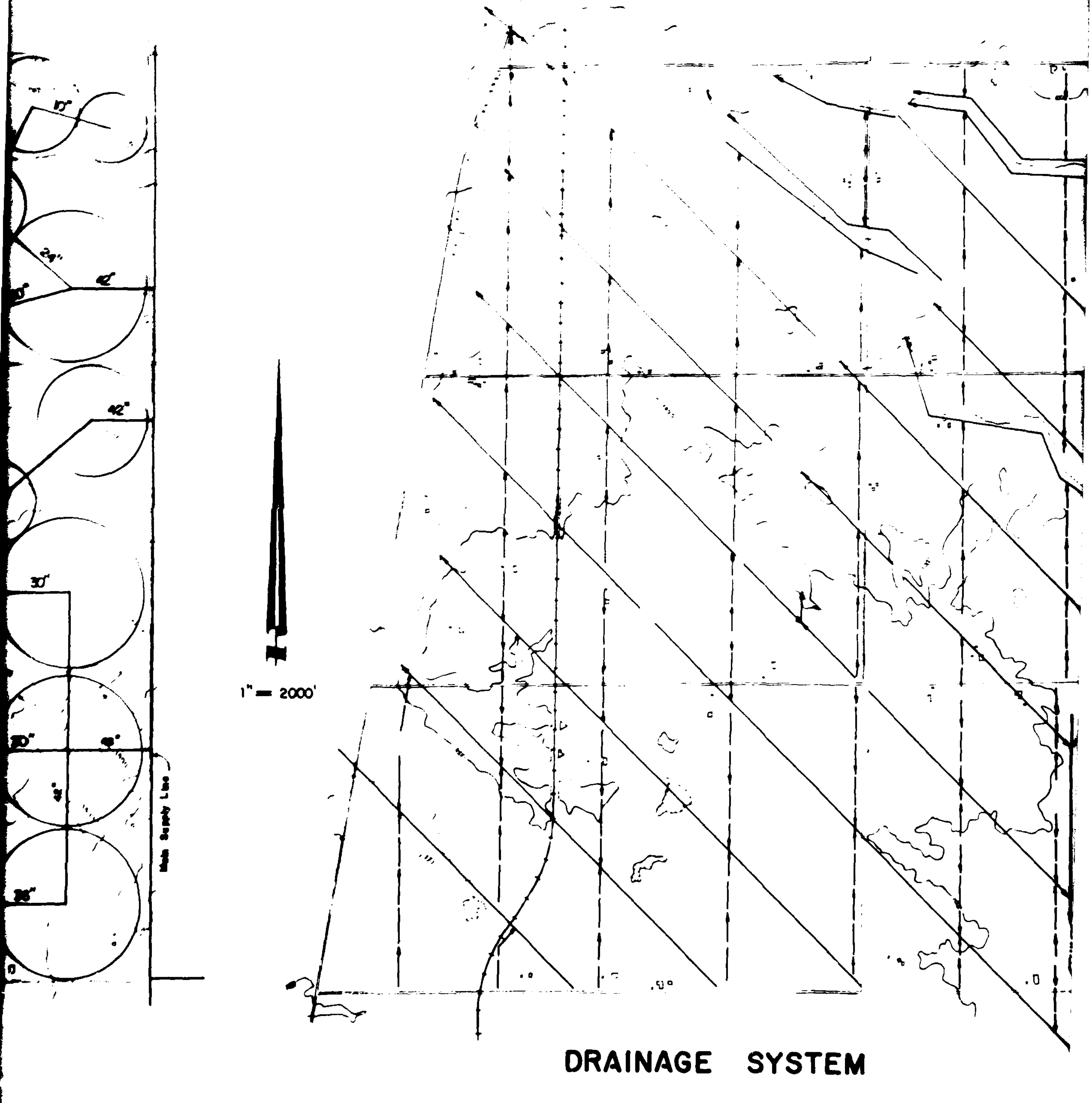
The principal type of irrigation equipment to be used can best be described as a center-pivot irrigation rig. This rig consists of a series of articulated truss spans extending from one central point called the pivot. Located at the outer end of the first span and at the end of each additional span is an electrically-driven wheel arrangement. The speed of rotation of the entire rig around its center pivot can be electrically controlled through the variable speed of the individually-controlled wheels. The outer end of the rig will be traveling at a greater circular speed than any point closer to the pivot. Each rig can cover increments of areas up to a total of 300 to 400 acres for the largest size rig.

The wastewater effluent from the storage reservoir is fed to the center pivots of those rigs being sequenced for use at any particular stage of the operating program for the entire area under irrigation. One or more pumps, depending upon the size of the system, take effluent from the storage reservoir and then pump it through a force main into the distribution piping network, terminating at the series of center pivots discussed above. See Figure III-2.

As the water issues from the center pivot, it flows radially through a properly-sized pipeline to individual spray nozzles, drip tubes, or other fixtures mounted at intervals along the trusses between the electrically-controlled drive wheels. The applicators are sized to produce a uniform application rate of effluent over the

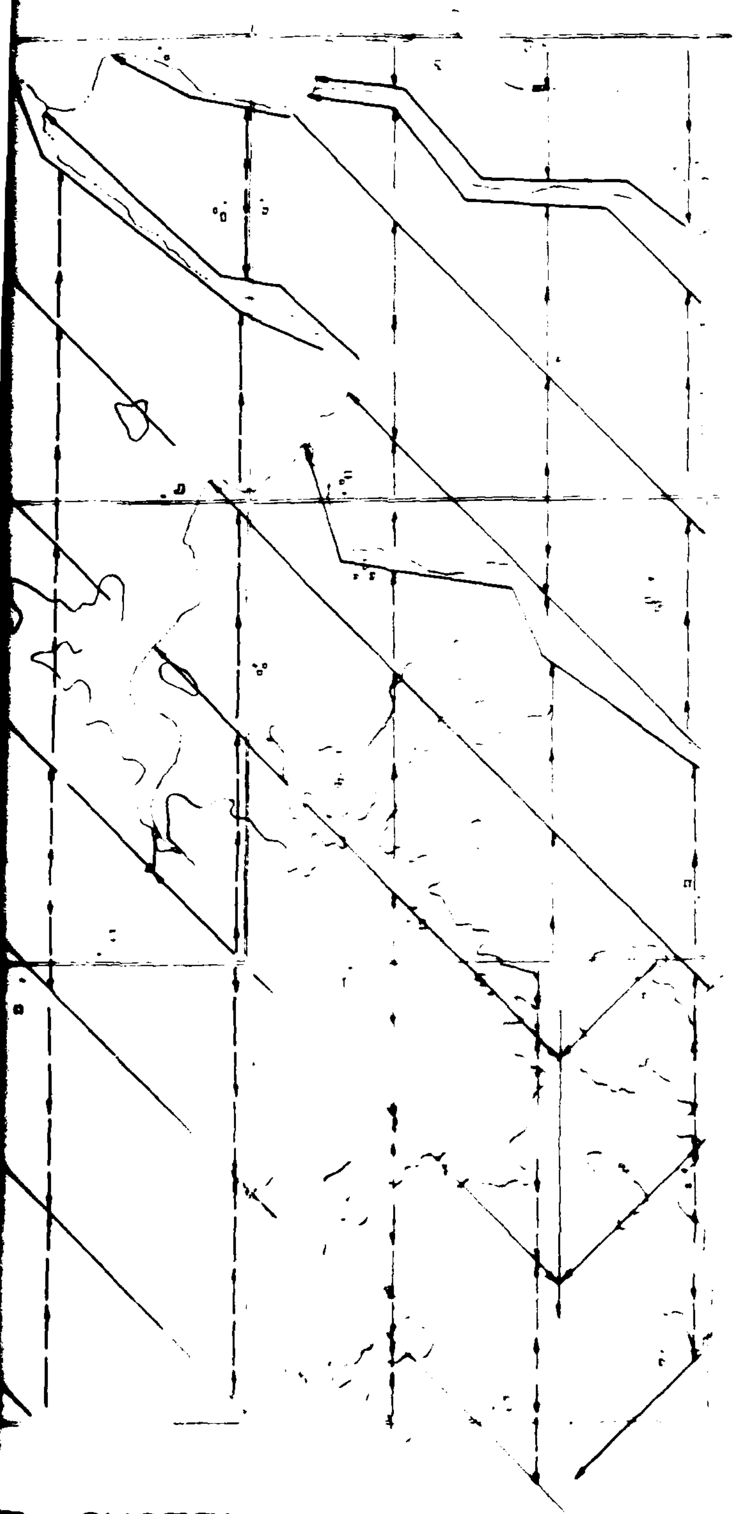


IRRIGATION SYSTEM



DRAINAGE SYSTEM

.7



NOTES:

Drain Laterals are spaced at 20-foot centers at depths varying from 36 to 42 inches and are made of 3-inch corrugated plastic pipe

LEGEND

Pressure Pipe

Pivot Irrigation Rig

Solid-Set Sprinklers

3" Plastic Pipe

Collectors or Mains

Streams or Drainage Channels

Figure III-2

TYPICAL LAY-OUT

LAND TREATMENT SITE

FOR A
4800-ACRE SITE

E SYSTEM

3

entire area under command of the rig.

The effluent after leaving the applicators reaches the ground surface beneath the rig and percolates through the "living filter" of soil, nourishing the particular crop under cultivation. The volume of water in excess of the crop needs then finds its way into the artificial subsurface drainage network, to be described in the next section.

DRAINAGE SYSTEM

Description, Design, Installation, and Operation. Directly beneath the land area surface being irrigated, as described in the previous section, there is to be installed an artificial drainage system. The depth to the tile utilized in this system is determined by a number of factors, including the depth of the various soil horizons encountered, as well as the permeability of the soil.

The tile lines are sized according to the volume of flow anticipated. Tile lateral lines at spacings dictated by soil characteristics are connected to a series of headers and thence to main lines, all collecting the return flow of the effluent after it has passed through the soil filter, just as a network of lines had previously distributed the effluent to the irrigation equipment for application to the soil surface above.

Recent advances in technology should allow installation of inexpensive plastic pipe drain lines by means of laser-operated equipment to assure uniform depth. A nylon envelope has also been developed

for simultaneous installation with the plastic pipe, which enables good control of silting in the drain lines.

Once installed, the drain lines themselves will provide relatively trouble-free operation. The combined flow from the entire drainage system of any one land treatment area will require monitoring as to quality for possible re-cycling of some portion of the flow during certain periods of time, such as in the case of a tile line break.

It is proposed that the return flow be otherwise handled in one of several different ways, depending upon hydrologic conditions existing from one growing season to the next. The flow can be used to augment local stream flow directly; it can be stored in upland reservoirs and then released at strategic intervals for stream flow augmentation; it can be returned to its basin of origin via conduit if need be; or it can be sent directly to Lake Erie via conduit or canals should the volume of flow generated exceed the capacities of the streams in the immediate vicinity of the land treatment site.

SLUDGE MANAGEMENT

The disposal of the solid by-products of wastewater treatment is not, strictly speaking, an integral part of the various systems for the final treatment of the liquid effluent. Accordingly, the responsibility for design and costing of the sludge management subsystems was assigned to either the Domestic and Storm Runoff Contractor (Havens and Emerson, Ltd.) or the Land Treatment Contractor (Wright-McLaughlin Engineers), depending upon the method of disposal

determined for each case in the formulation of the twelve plans. Whenever sludge was to be disposed of by incineration, and subsequent landfill, the process was costed by Havens and Emerson, Ltd. Wright-McLaughlin designed and costed the sludge management components, wherever the choice was disposal on agricultural or strip-mined lands, regardless of whether the sludge was generated in plants or aerated lagoons preceding land treatment of the effluent, or whether the stabilized sludge was produced in the course of all water-based treatment.

The twelve formulated plans require a variable mix of three sludge management methods. (Use of traditional landfill methods using partially stabilized and concentrated sludge has been declining in popularity in recent decades in urban areas. The increasing amounts of sludge to be disposed of, coupled with the decreasing availability of "land to be consumed" at reasonable distances from the source, have contributed to this trend. Water pollution problems associated with landfill operations within the Three-Rivers watershed also militate against landfill with partially stabilized sludge.) Factors influencing the choice of sludge disposal include the individual sewage treatment plant size, location and method of secondary treatment selected for the influent wastewater as well as capital and operating costs, sludge characteristics, land availability, and possible uses as a soil conditioner or fertilizer.

Selection of a particular method of sludge disposal involves individual consideration of the various factors involved. Among these

are the existing eutrophication in Lake Erie, which would be further aggravated by disposal there; the environmental objections to disposal by discharge into streams; the humid continental climate of northeastern Ohio favorable to biological processes necessary in land disposal; the already existing high degree of urbanization of the area; the severity of existing air pollution; the domestic and/or industrial sludge characteristics; the relative proximity of strip-mine areas amenable to use for disposal.

With the above considerations in mind, the three methods of sludge management used in the formulated plans are briefly described below.

> Incineration. This method is generally less costly than traditional landfill, even with disposal of the resultant ash to landfill. During the incineration process, the temperature of the exhaust gases must be raised to about 1500 degrees Fahrenheit to eliminate noxious odors, toxic by-products, and vaporize the remaining water in the sludge. An additional fuel, such as natural gas, is required. Fly ash and sulfur dioxide are mostly removed by wet scrubbers, but other contaminant problems are solvable to varying degrees.
>
> At best, it is an inefficient, negative process requiring constant attention and practical only on a large scale. Economic advantages must be carefully weighed against the severe economic and environmental drawbacks when comparing incineration with alternative methods of disposal.
>
> Agricultural Application. This is an age-old method wherein organic matter and plant nutrients provide needed materials for current crops, while also helping to rebuild depleted soils. Optimum rates of sludge application must, however, be determined to avoid buildup on the soil of elements detrimental or toxic to plant life.

Sludge application crop land is likely to prove the best disposal method under amenable physical conditions and well-managed application for optimum results, including monitoring of key elements and crop rotation. A relatively small amount of land is involved for the annual volume of sludge produced and the time period in years between regulated applications could be in the magnitude of from ten to twenty years.

Strip-Mine Application. The desolate condition of 200,000 acres of strip-mined lands in south-eastern Ohio provides an opportunity not only for sludge disposal but also for rejuvenation of the land and its return to productive use. Enactment of new laws requiring some restoration of these lands may be necessary to facilitate and promote the application of heavy doses of matter with a high pH (to neutralize acid conditions), high organic content, and high content of plant nutrients, such as sewage sludge.

The existence of an abandoned coal slurry pipeline, with attendant right-of-way, already extending from the Cleveland area to the heart of the strip-mined lands, makes 75,000 acres accessible. Legal difficulties might well be minimized in the construction of necessary pipeline and distribution facilities.

Use of new methods of injecting sludge in depth could make possible sustained yield of heavy plant growth not possible by mere surface application. Surface application alone of 100 dry tons/acre of sludge would be to a virtually unlimited depository, especially if strip-mining continues.

Disadvantages of land disposal would become lost in the overwhelming acidity and metal content of the strip-mine soil, leading to many beneficial ecological results. Due to needs for land leveling and rock removal if used for agricultural purposes, the lands might best lend themselves to wildlife and recreational purposes wherein woodlands and numerous restored ponds would exist.

Agricultural Facilities. The stabilized sludge from the facultative lagoons would be dredged at two to ten year intervals. This would be an annual, though seasonal, operation in western Ohio.

Thence, sludge would be transmitted via pipeline to a central distribution point with about five miles of lagoons, where a sludge holding tank would provide one to two days storage. From there, sludge would be pumped in temporary lines to fields where tractors pulling pressure injection plows would place ten to forty tons per acre at the selected depth, generally about eighteen inches. Each plow would have from six to ten injectors. Supplying the sludge by tank truck would be an alternative to the temporary pipeline.

Stabilized sludge from the smaller in-basin facultative lagoons would be removed at infrequent intervals under contractual arrangements with local sludge handlers, who, in turn, would arrange for the lands to be treated. Transportation would generally be by truck because of the smaller volume involved.

Deposition in earthern storm drainage detention ponds, based upon existing practice, would be removed once each five to ten years for topsoil and landfill operations. Utility trench backfilling material can be expected to have a sale value of about 25 cents per cubic yard.

Strip-Mined Facilities. Sludge recycled to strip-mined lands are transported via permanent pipeline serviced with high-pressure pumps. Sludge is three to five per cent solids. The pipeline terminus is at a sludge holding facility sized to provide storage during inclement weather, and when ground freezing exceeds about three inches. Temporary pipelines from the storage facility deliver sludge to the current workings. The strip-mined lands are shaped, if necessary, and the sludge injected as with the agricultural tractors and plows. Application rates from 40 to 100 tons per acre are anticipated. A second application, using a "water winch" technique would be made about three years later if deemed necessary.

Harrison County Potential Farm Land. The upgrading of virgin, but nearly sterile, potential farm land is the sandstone area in and near Harrison County provides a large acreage needing sludge treatment.

The sludge would be both injected and applied on the surface with a first-year application of about 40 tons per acre, with subsequent applications of perhaps from five to ten tons per acre. Land management would be aimed at building an organic soil content with suitable nutrients, which could maintain itself without regular sludge applications after about five years of initial treatment. Ideally, this land should be given the benefit of sewage effluent as well, so that the farmer would not need to depend upon artificial fertilizers following the end of sludge applications.

MISCELLANEOUS (Monitoring, Administration Buildings, Laboratories)

Monitoring. The nutrient-enriched wastewater effluent being dispatched to land treatment areas to be used for irrigated agriculture would be free of excessive concentrations of toxic or undesirable constituents. Also, to ensure proper knowledge of the concentrations of the various constituents, such as phosphates, nitrogen, and heavy metals, in the wastewater effluent being sent to the various land areas for treatment, it is essential that a system for monitoring specific constituents be established. The return flow from the artificial subsurface drainage system must also be similarly monitored to ensure that the quality of this flow will be compatible with the quality standards established for the receiving surface and ground water resources at all times.

Monitoring would be carried out by means of wells for ground water resources and by other suitable techniques for surface flows to existing water courses. A comprehensive monitoring system would enable accurate scientific analysis of early-action test plots to be made with regard to such parameters or application rates to achieve desired concentrations of various nutrients for optimum crop results.

Administration Buildings. In conjunction with the possible establishment of a regional authority to administer and coordinate the wastewater management program for the many constituent political entities within the study area, suitable office space facilities for headquarters and regional office personnel may have to be provided.

Laboratories. In order to carry out the necessary testing in conjunction with monitoring, test-plot programs, and any other needs of the wastewater management program as dictated from time to time, adequate laboratory facilities must be established and staffed. It is assumed that the location of such facilities would be coordinated with the location of regional offices and housed in the same building. It is assumed that the timing of and comprehensive needs for the laboratory facilities by the regional authority would be such as to preclude the use of existing private laboratories, though private labs are preferred.

SECTION IV

AERATED LAGOONS

Some of the plans include aerated lagoons for secondary treatment, rather than more conventional activated sludge or trickling filter wastewater treatment plants. A description of the aerated lagoon process is presented here with technical data to provide the reader with additional insight into these facilities.

Aerated lagoons are characterized by the relatively large volume of wastewater under treatment at any given time, introduction of air into the wastewater, and creation of a suitable environment for bacterial action. In many ways, it can be thought of as a slow activated sludge system, and as it parallels natural processes.

Process Description. Aerated lagoons are basins in which an active biological mass, oxygen, and wastewater are brought together. The resulting biological system is a variation of the activated sludge process. Wastewater organics, in the presence of oxygen, are utilized by the active mass. Therefore, the basic biological relationships pertinent to activated sludge apply to aerated lagoons.

The particular lagoon system proposed for the study area consists of two stages; the first stage, or aerobic lagoon, and the second stage, or facultative lagoon. The amount of mixing created by the aeration equipment is the distinguishing factor between the two lagoons. An aerobic lagoon is one in which mixing keeps the solids in suspension.

In the facultative lagoon, some solids deposition occurs, although dissolved oxygen is distributed throughout the basin. In both lagoons, oxygen requirements are satisfied.

The aerobic lagoon converts the incoming BOD of the wastewater to cell tissue. Normal operation will result in a lagoon effluent containing one-third to one-half the raw BOD.

The contents of the facultative lagoon are not completely mixed, allowing a portion of the incoming solids and the biological solids produced in the aerobic lagoon to settle to the bottom. These solids undergo anaerobic decomposition. This produces a stabilized lagoon effluent.

Consideration must be given to several design factors: BOD removal, effluent quality, oxygen requirements, temperature effects, mixing requirements, and sludge production.

> BOD Removal - The removal of BOD through an aerated lagoon is primarily a function of detention time, temperature, biological solids concentration, and the raw wastewater characteristics.
>
> Effluent Quality - Two effluent parameters are most important in an aerated lagoon design under present practices -- BOD and suspended solids (SS) concentrations. BOD conversion and removal have been previously discussed. Effluent SS contain portions of the influent SS, biological solids, and occasionally small amounts of algae.
>
> Oxygen Requirements - The oxygen required for bio-oxidation is dependent upon the BOD removed, quantity of bacterial solids and nutrient levels. Since aerated lagoons operate at low mixed liquor suspended solids concentrations, oxygen requirements are most directly related to BOD

removal. The ratio of oxygen: BOD removed varies in the range of 0.7 to 1.4.

Temperature Effects - Reduced temperature affects the performance of aerated lagoons by (1) reducing the biological activity and thus treatment efficiency, and (2) possible formation of ice cover. Added heat can overcome the efficiency drop in the larger western Ohio aerated lagoon system.

Mixing Requirements - Proper aerated lagoon operation depends on complete mixing of the liquid and uniform oxygen dispersion. Generally, the amount of aeration equipment required for mixing (solids kept in suspension) exceeds the amount needed to satisfy biological oxygen demands.

Sludge Production - The production of sludge is minimal in the aerated lagoon. The bacterial activity is nearly sufficient to destroy the cells created each day. The influent contains some non-oxidizable fraction and some non-oxidizable solids are produced within the system. Periodic removal of settled sludge may be required, perhaps once each two, five, or ten years.

Aerated lagoons provide an economical alternative in biological wastewater treatment. Low capital costs, simplicity of operation, and low operation and maintenance costs combine to offer a system which is capable of providing an effluent typical of conventional activated sludge plants,which is amenable to land treatment. (At Paris, Texas, wastewater has 500 to 900 mg/l of BOD applied to land, with resulting 99 per cent removal.)[5]

Aerated Lagoon Schematic Design. The aerated lagoons proposed for the Cleveland/Akron/Three Rivers Basin are shown schematically in Figure No. IV-1. This Figure represents the design considerations

FIGURE IV-1

AERATED LAGOON SCHEMATIC FLOW DIAGRAM

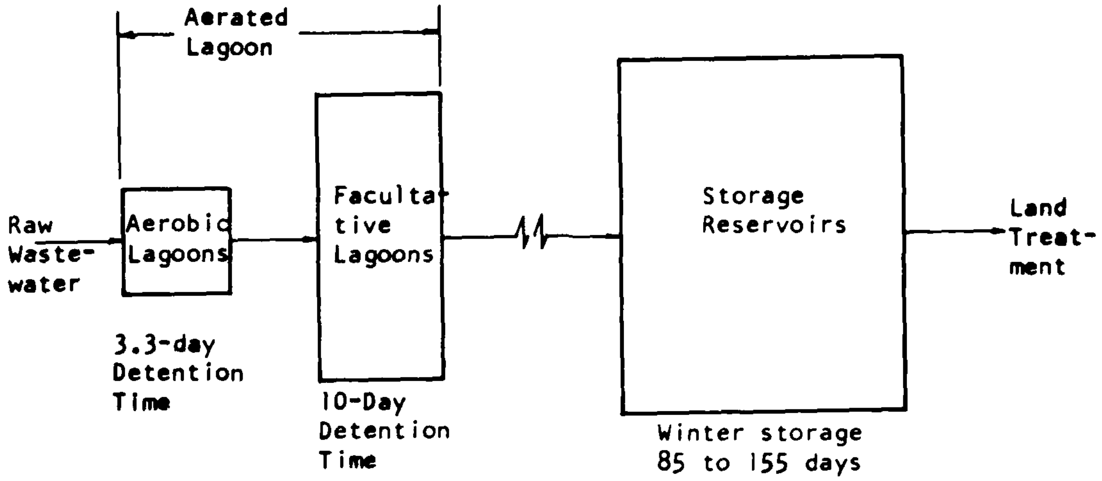
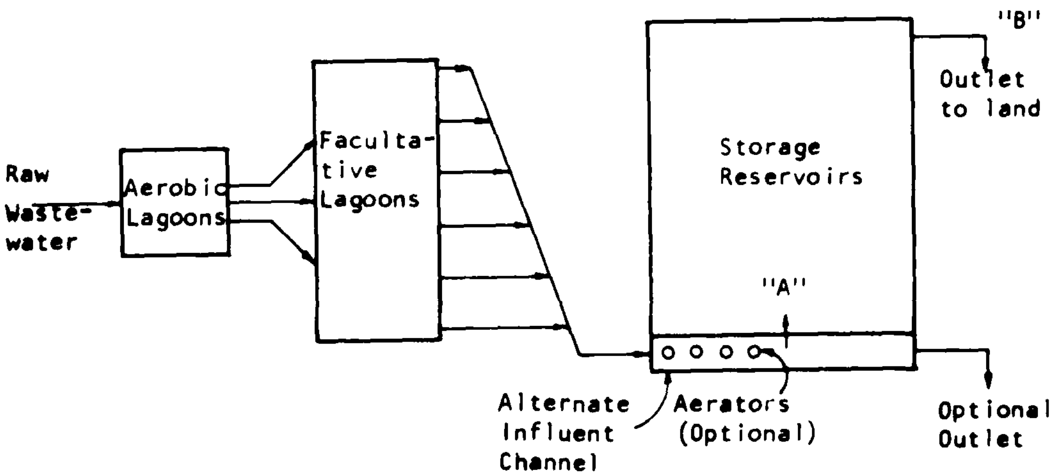


FIGURE IV-2

OPTIONAL AERATION AND ROUTING FEATURES



presently employed and reflects recent developments by manufacturers of aeration equipment.

Design criteria and efficiencies for aerated lagoons are summarized in the following table.

TABLE IV-1

AERATED LAGOON NON-WINTER REMOVAL EFFICIENCIES
(Without benefit of reservoir storage)

Treatment Unit	Influent BOD (mg/l)	Effluent BOD (mg/l)	Per Cent BOD Removed	Influent SS (mg/l)	Effluent SS (mg/l)	Per Cent SS Removed
Aerobic Lagoon	178[1]	78[2]	56	182[1]	111[2]	39
Facultative Lagoon	78	22[2]	72	111	50[2]	55
Aerated Lagoon[3]	178	22	87	182[1]	50	73

1. Havens & Emerson, Cleveland, Ohio
2. Lightnin-Mixing Equipment Co., Inc. Rochester, New York
3. Aerated Lagoon = Aerobic + Facultative Lagoon.

Winter operation of aerated lagoons will affect removal efficiencies. Ten to twenty per cent reductions could be expected, although the lower range can be used when temperature changes are gradual and allow sufficient time for the bacterial acclimation. For the Cleveland-Akron Study Area, a twelve per cent reduction in removal efficiency was assumed. Any heat added to the process from power plants would increase the winter removal efficiency.

The previous discussion centered around the aerated lagoon as a treatment system. However, for complete treatment prior to land

application, the effect of the storage reservoirs should be considered. These reservoirs form an integral part of the treatment process by providing an environment for biological activity and settling, in addition to winter storage. This is particularly important, as the aerated lagoon winter operation produces the lowest seasonal treatment efficiency.

Sizing economics indicate storage reservoir depths of fifteen to twenty feet. Reservoirs equipped with aeration devices may be considered facultative ponds. Aeration provides enough oxygen to maintain aerobic conditions in the surface zone. However, incomplete mixing allows accumulation of solids in the bottom anaeorbic zone. An intermediate zone, partly aerobic and partly anaerobic, exists between the two.

Three storage reservoirs are not equipped with aeration devices and should be considered anaerobic ponds.* (A shallow surface zone can be considered aerobic.) Stabilization is by precipitation and anaaerobic conversion of organic matter to CO_2, CH_4, gaseous end products, organic acids, and cell tissues.

Removal efficiencies during winter storage in these reservoirs should range from 75 to 95 per cent. An average of 85 per cent was assumed. (Heat added to the western Ohio winter reservoir would increase the stabilization.) Design criteria and efficiencies for aerated lagoons and storage reservoirs are summarized in the accompanying table. These values apply to winter operation, without aeration, and without heat added.

---

*During wintertime, minimal treatment periods; however, effluent BOD per acre of surface area loading to reservoirs is considerably lower than normal design loadings to oxidation ponds, such as in North Dakota.

TABLE IV-2

AERATED LAGOON AND RESERVOIR: WINTER REMOVAL EFFICIENCIES

Treatment Unit	Influent BOD (mg/l)	Effluent BOD (mg/l)	Per Cent BOD Removed	Influent SS (mg/l)	Effluent SS (mg/l)	Per Cent SS Removed
Aerated Lagoons	178[1]	45	75	182[1]	71	61
Storage Reservoir	45	7	85	71	11	85
Overall Treatment[4]	178	7	96	182	11	94

1. Havens & Emerson, Cleveland Ohio
4. *Overall treatment = Reduced aerated lagoon* treatment due to winter operation + storage reservoir treatment during winter storage.

To further increase the removal *efficiencies of the aerated* lagoon treatment, reservoir channel aeration is an option. This appears schematically in Figure No. IV-2. Aeration is supplied to a potential channel between the facultative lagoon and the storage reservoir. This would also be beneficial during summer operation when residence time in the reservoirs could approach zero.

During winter operation "B" is closed and the reservoir is allowed to fill. For the irrigation season, open "B" and allow facultative lagoon effluent and stored water to mix prior to land treatment.

The effluent produced by aerated lagoons is comparable with other basic biological treatment plants. It is highly stabilized, contains low concentrations of BOD and SS; it is most amenable to land treatment and crop irrigation.

Component Layouts. The aerated lagoon systems, including the reservoir, will have an overall winter treatment efficiency of:

BOD : 96 per cent
SS : 95 per cent

without considering use of waste heat or aeration of the winter reservoirs.

The winter reservoirs all are planned for aeration in this preliminary design, except where several miles of open buffer land is indicated as surrounding the particular system. Aeration of the reservoir would increase the treatment removal efficiency. For final design considerations, aeration should be considered optional for all reservoirs.

Waste heat from the proposed western power plant will be routed to the western aerobic lagoons during winter, as well as to the adjacent facultative lagoons. This will increase the removal efficiency during the winter period through the two steps of aerated lagoon treatment to near the summer efficiency.

It is planned that all wastewater will be routed through the reservoir during the entire year, and, therefore, the reservoir will always serve as a third step in the effluent stabilization process, bringing overall system treatment efficiencies for BOD to approximately 98 per cent during the non-winter period. The aerated channel alternate would not be utilized unless found to be desirable for winter operation efficiency improvement. This would be a final design option.

The aerobic lagoon cells vary in design layout from location to

location, and in accordance with the loadings. For instance, the western Ohio lagoon cell is twenty feet deep, with average dimensions of 875 feet by 420 feet. Eight aerators are planned at 75-horsepower each. There would be forty such cells. The facultative lagoons would be twenty feet deep, with average dimensions of 1,050 feet by 350 feet. Each cell would have three aerators at 100-horsepower each. There would be 120 such cells. The total surface area of aerobic cells is 440 acres, and the total surface area of facultative cells is 1,320 acres.

The smaller aerobic lagoon cells and facultative cells are fifteen feet deep, with moderate sized facilities at eighteen feet of depth. The areas are commensurate with the rate of flow, providing a total of 13.3 days of detention for the full winter period of twelve to sixteen weeks.

Dikes are constructed with impervious linings and sealed bottoms. The inside side slopes are at 4:1, with a fifteen-foot to twenty-foot top width. All dikes are suitably riprapped to protect against erosion.

The capability of the land to treat irrigation water with organic loadings of over 500 mg/l to 99 per cent removal efficiencies has been documented at Paris, Texas with the overland flow method.[5] Thus, removals as indicated herein are greater than considered necessary. The layout as proposed has significant safety factors included.

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5. "An Evaluation of Cannery Waste Disposal by Overland Flow Spray Irrigation," Final report on a study project prepared for the Campbell Soup Company by C. W. Thornwaite Associates, Publications in Climatology, Vol. XXII, No. 2, September, 1969.

SECTION V

WASTEWATER RENOVATION

The renovative capacity and efficiency of the land treatment systems varies from soil to soil, with crops grown, with the character of irrigation and drainage, and with the quality of the effluent being applied as irrigation water.

The land treatment methods developed during the Cleveland-Akron and Three-Rivers Watershed Areas Wastewater Management Study include:

1. On Chili Soils
   a. Center-pivot irrigation techniques.
   b. Corn, hay, and pasture crops.
   c. Application rate of 60 inches per year.

2. On Cardington-Bennington Soils
   a. Center-pivot and/or solid-set irrigation techniques.
   b. Reed canary grass, hay, pasture, and corn crops.
   c. Application rates of 50, 75, and 90 inches per year.*

3. On Mahoning-Ellsworth Soils
   a. Overland runoff/infiltration techniques.
   b. Reed canary grass or other grasses.
   c. Application rates of 90 inches per year,* and 150 inches per year for separate storm runoff.

The renovation of the wastewaters by these methods will exceed the proposed NDCP standards.[1]

---

*Rates which were used for purposes of preliminary schematic design and costing. Early-action testing and monitoring are expected to demonstrate that optimum rates may approximate 120 inches per year.

The following table presents the projected quality of the irrigation water following secondary biological treatment and assuming a mix 81 per cent municipal-industrial sewage and 19 per cent storm water. The concentrations shown are conservatively high for computational purposes.

TABLE V-1

IRRIGATION WATER QUALITY

Constituent	Municipal-Industrial and Combined Wastewater (mg/l)	Storm Runoff (mg/l)	Municipal-Industrial Combined and Storm Runoff (mg/l)
Suspended Solids (SS)	25	25	25
Biochemical Oxygen Demand (BOD)	15	15	15
Chemical Oxygen Demand (COD)	69	69	69
Total Dissolved Solids (TDS)	520	200	460
Nitrogen (N)	19.7	2.2	16.4
Phosphorous (P)	10.2	0.5	8.3
Heavy Metals	2.0	0.2	1.7
Virus			
Bacteria			

The quality of the drain tile effluent, after land treatment, is represented in the following tables for each of the methodologies employed.

TABLE V-5

RENOVATION OF EFFLUENT WITH CHILI SOILS
BASED ON 60 INCHES/YEAR
MUNICIPAL EFFLUENT

Constituent	Removal Rate (Per Cent)	Return Flow (mg/l)
SS	99	<0.3
BOD	95-99	<0.8
COD	95-99	0.7-3.5
TDS	5-10	450-500**
N	75-90*	2-5
P	98	<0.2
Metals	95-99	Trace
Virus	99	
Bacteria	99	

* The removal rate will depend on the crops grown, yields, and product removal. Unexplained losses of up to 50 per cent to the atmosphere may occur.

**Average values are shown; lower or higher values are possible, depending on rainfall and evapotranspiration rates.

TYPICAL IRRIGATION MANAGEMENT

A typical irrigation and drainage management opportunity involving Reed canary grass has been investigated for utilization with the Cardington-Bennington soils. The approach was twofold; first, to review a wide range of irrigation application rates from the operational feasibility point of view; and, secondly, to identify optimum application rates conjunctively with the nitrogen, aeration, and hydraulic

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capacity constraints. The heavy metal and organic loading impacts have been discussed in the Land Treatment Phase I Report, with the conclusion that metals can be properly and safely managed, and that the potential for the soil to decompose organic material is high.

Two methods of application are proposed. Wherever the shape and size of fields are optimum, center-pivot machines would apply the effluent through spray nozzles. The corners between these units and other odd-shaped areas would be irrigated, using permanent-type solid-set sprinkler systems. Center-pivot units are recommended wherever practical because of their lower initial cost and operating pressure, though solid sets offer more refined control. However, solid sets could be selected for use in place of center-pivots, as desired.

The recommended drainage system would be installed first, followed by the irrigation system. No unusual or expensive land preparation would be required.

Soil preparation would begin with plowing approximately seven inches deep with a conventional moldboard plow. In the case of the center-pivot, the plowing should be done in such a way as to move the soil toward the future wheel track. To do this, the machine is operated without irrigating for one revolution to locate the wheel tracks. Plowing is then begun by plowing soil onto the wheel track from each side. The plowing is then completed, leaving the dead furrow midway between the wheel tracks. The result is a slightly elevated area for the wheels to run on which avoids potential traction problems. The surface between the tracks should then be smoothed using a landplane.

The grass seed should be planted with a drill. Until the grass is fully established, water applications should be limited to only that amount which is needed to keep the soil moist. Water application should then be gradually increased, taking about two years to reach the design capacity.

The proposed irrigation season is 36 weeks, of which no irrigation would take place during six weeks which would be reserved for harvesting the hay and for temporary shutdown during very excessive rainfall. The resulting weekly rate would be two inches per week for 60 inches per year, three inches per week for 90 inches per year, and four inches for 120 inches per year. See Figure V-1.

Irrigation Application, Solid-Set. The Ohio Irrigation Guide suggests a maximum application rate of 0.4 inches per hour for these soils. It is further stated that with adequate ground cover this rate can be doubled (0.8 iph).[3] However, with solid-set sprinklers, there is no need to maximize rates. Therefore, the proposed rate is 1/3 iph, which is well below the maximum suggested. Two inches of effluent would be applied during each irrigation requiring one irrigation per week for 60 inches per year, three irrigations each two weeks for 90 inches per year, and two irrigations per week for 120 inches per year for the solid-set sprinklers.

The resulting application time would be six hours per irrigation, which is the same as for the Campbell Soup operation at Paris, Texas during the cool months.[4] However, at Paris, the resting time between irrigations was only eighteen hours. This proposal would provide

resting periods of 162, 106, and 78 hours for annual applications of 60, 90, and 120 inches, respectively. Automated permanent solid-set sprinkler systems provide great flexibility so, if for any reason it is desired to use a resting period of only eighteen hours as at Paris, application times could be reduced to two-thirds, one, and one and one-third hours for annual applications of 60, 90, and 120 inches respectively.

Aeration and Hydraulic Capacity. Three potential alternative irrigation plans, which would be fully tested and monitored during the early-action program, propose annual applications of (1) 60 inches per year, (2) 90 inches per year, and (3) 120 inches per year. Each irrigation will be six hours, or less, in duration, applying water at 0.33 inches per hour.* Respective irrigation schedules will be: (1) one per week, (2) two every three weeks, and (3) two per week. Weekly applications are therefore: (1) two inches, (2) three inches, and (3) four inches. Time intervals between irrigation (from end of an irrigation to beginning of next) are: (1) 162 hours = 6.75 days, (2) 106 hours = 4.4 days, and (3) 78 hours = 3.25 days.

There are two approaches available to estimate the performance of tile drains: one would apply an analytical method, treating the system as a non-steady one, such as is used in design of drains for irrigated lands.[6]

However, for this case, a better approach is available because of the tile drain experiments in Ohio on soils very similar in texture

*For solid-set applications.

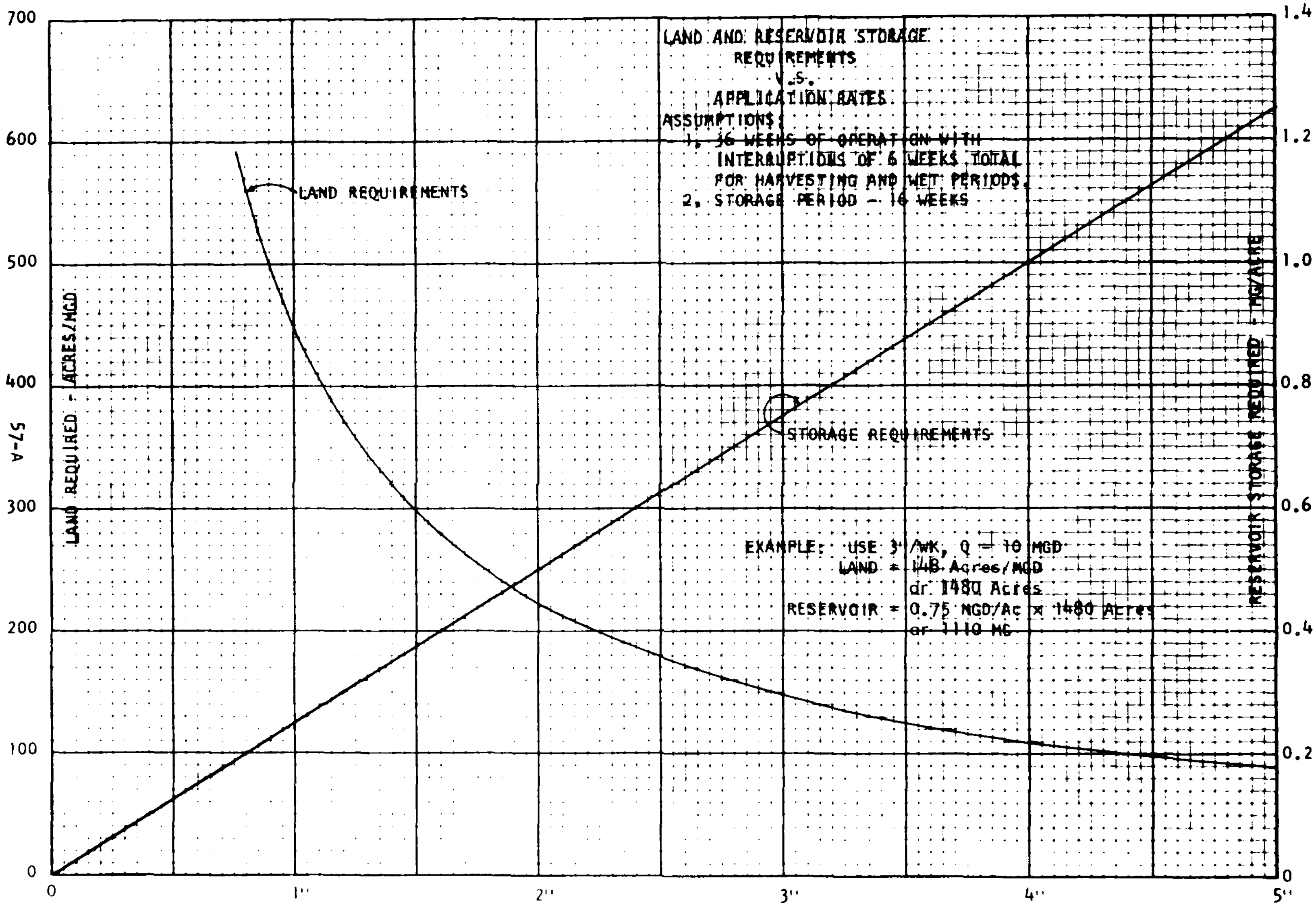

LAND AND RESERVOIR STORAGE
REQUIREMENTS
V.S.
APPLICATION RATES
ASSUMPTIONS:
1. 36 WEEKS OF OPERATION WITH
INTERRUPTIONS OF 6 WEEKS TOTAL
FOR HARVESTING AND WET PERIODS.
2. STORAGE PERIOD — 16 WEEKS
LAND REQUIREMENTS
STORAGE REQUIREMENTS
EXAMPLE: USE 3"/WK, Q = 10 MGD
LAND = 148 Acres/MGD
or 1480 Acres
RESERVOIR = 0.75 MGD/Ac × 1480 Acres
or 1110 MG
LAND REQUIRED - ACRES/MGD
RESERVOIR STORAGE REQUIRED - MG/ACRE
APPLICATION RATE - INCHES/WEEK
0
100
200
300
400
500
600
700
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1"
2"
3"
4"
5"

FIGURE V-1

and other characteristics to the soils in question.[7, 8] The experience from these installations should be excellent guides to estimating tile drain performance and are preferred over the analytical approach, which depends on idealizing the system.

There are two questions to be answered in evaluating a drainage system:

1. Will the water table decline following irrigation be rapid enough?

2. Will aeration requirements of the crop be met?

In regard to water table reaction, Reference No. 8, Figure No. 6, gives water table drawdown at mid-point between tile as a function of tile spacing. The experimental system happens to have tile at 36-inch depth, and impermeable material occurs at 36 inches below the tile. This is nearly identical to the system required for the Cardington-Bennington soils, with the possible exception that impermeable material may in some cases be nearer the tile. The reader is referred to Table II-1 of the Land Treatment Phase I Report.[1] However, the theoretical effect of this variation is known to be small (<10 per cent); so it can be neglected without harm to the spacing estimates.

Assuming as an initial condition that the water table is at or near the surface, a condition to be expected immediately following irrigation in the extreme case, the question is, what rate of water table decline can be expected for a given drain spacing.

The following tabulation summarizes tile performance expected

for three spacings and the three levels of annual application.

TABLE V-6

DRAWDOWN AS AFFECTED BY TILE SPACING

Tile Spacing (feet)	Rate of Drawdown (ft/day)	Total drawdown in feet between Irrigations* for Annual Applications of: 60 Inches	90 Inches	120 Inches
40	0.3	2.0	1.3	0.9
35	0.4	2.7	1.8	1.3
30	0.6	3.0	2.6	1.9

*Based on solid-set sprinkler applications.

Oxygen requirements (aeration) within a root zone are met by diffusion of air, provided continuous channels through the soil exist. At moisture content near saturation, water fills pores to an extent that channels are blocked. However, at saturation of about 0.8 (80 per cent of total pore volume occupied by water) continuous channels are open for air diffusion. Therefore, the saturation at any point to which aeration is desired must be examined in order to determine if that point (and the soil above it) can be aerated.

Aeration need not be continuous with time within the root zone, but various plants have critical lengths of time, beyond which, without aeration, the plant suffers adverse effects (growth reduction). In general. most standard field crops can tolerate three days without aeration; many can tolerate four or five days. Grasses are among the most tolerant.

Reference No. 7, Figure No. 7, provides an excellent estimate of moisture content at a depth of six inches as a function of water table

depth. If saturation at six inches can be shown less than 0.8 after four days, aeration should be adequate for all grasses. Water table drop in four days, based on daily rates given in Table V-6 for tile spacings of 40, 35, and 30 feet are, respectively: 1.2 feet, 1.6 feet, and 2.4 feet at the ground water table high point midway between tiles.

The data of Reference No. 7 are soil moisture per cent on a weight basis, which must be converted to volume basis as follows:

$$\theta = \theta_w \frac{\rho_s'}{\rho_w}$$

Where θ = Volumetric moisture content, per cent

θ_w = Moisture content, weight basis, per cent

ρ_s' = Bulk density of soil

ρ_w = Density of water = 1.0

Then saturation can be calculated as:

$$S = \frac{\theta}{\Phi}$$

Where S = Saturation, $0 \leq S \leq 1.0$

θ = Volumetric Moisture Content

Φ = Total porosity

Total porosity in the "A" horizon soil, according to Reference No. 7, is found from θ_w at saturation given as 43 per cent (approximate). Bulk density of "A" horizon is estimated as 1.3. Total porosity is:

$$\Phi = \theta_{sat} = (.43)\left(\frac{1.3}{1.0}\right)$$

$$\Phi = .56 \qquad \text{("A" horizon, 0 - 12")}$$

Reference No. 7, Figure No. 7, gives moisture content θ_w at six inches depth with water table at 1.2 feet (= 14 inches) as θ_w = 32.5 per cent. Converting θ_w to volume basis,

$$\theta = (32.5)\ (\frac{1.3}{1.0})$$

$$\theta = 42.3 \text{ per cent}$$

Then saturation at six-inch depth is:

$$S = \frac{\theta}{\Phi} = \frac{42.3}{56}$$

$$S = 0.75$$

It may be concluded that saturation at six-inch depth after four days or less will be less than the critical limit for aeration of S = 0.8. Therefore, adequate aeration for grass production is assured under all three tile spacings and for the three levels of annual irrigation under consideration. (The only question would be forty-foot spacing with an application rate of 120 inches per year where drawdown at midpoint in 3.25 days (78 hours) is only 0.9 feet (= eleven inches). By Figure No. 7, θ_w = 34 per cent, and calculation as before shows S = 0.79. Therefore, adequate aeration is expected at six-inch depth in less than four days.)

However, rainfall is expected to occur at times when the profile is draining after irrigation and, thus, to prolong the time of inadequate aeration. Fortunately, evapotranspiration through the grass crop will ameliorate this problem. Estimated evapotranspiration is

0.2 inches per day much of the summer. Between irrigations of 3.25 days (120 inches per year), evapotranspiration will extract 0.65 inches of water, enough to aerate the top six inches.

During rain storms, irrigation would cease. Operationally, a forecast of rainfall by a weather observer would dictate the stopping of irrigation from four to twenty-four hours ahead of precipitation, though the timing is not critical. Following is a tabulation of six-hour rainfall amounts as related to frequency of occurrence.

TABLE V-7

DEPTH-FREQUENCY FOR SIX-HOUR DURATION RAINFALL[9, 10]

Frequency in Years	2	5	10	25	50	100
Depth in Inches*	1.8	2.3	2.8	3.1	3.4	3.8

A drain system with tile at 36-inch depth and spaced forty feet apart will serve the drainage needs of a grass crop on the Cardington-Bennington soils for each of the three annual application rates under consideration, as demonstrated by this solid-set sprinkler example.

This recommendation is based on actual field experience on soils of similar drainage characteristics. The estimates made on this basis should be conservative for Cardington-Bennington sites because these soils are slightly lighter in texture with higher permeability.

In addition, however, all planning and costing for drainage design is based on 70 per cent of the Cardington-Bennington soils having tile spacing of twenty feet, with the remaining 30 per cent of the land having a spacing of thirty feet. This closer spacing would

*It should be noted that the soil moisture storage capacity approximates 0.15-0.2 inches/ inch of depth (2 inches/foot). Infiltration capacity with continuous vegetation exceeds two inches/hour. (Figure V-3)

provide an additional drainage reliability factor, though in the early action field testing the need for this closer spacing should be thoroughly investigated to determine whether or not the forty-foot spacing would be preferable in the interest of further cost reduction.

Irrigation Application, Center-Pivot. The center-pivot rig irrigation application varies from the solid-set rate because of hydraulic constraints in the rig concept and design. The center-pivot rig would irrigate continuously during its revolutions, and would continuously rotate, except during rainy periods or emergencies. The rig would travel at a rate of three revolutions per day, laying down either approximately 0.1, 0.15, or 0.2 inches per revolution to provide two, three, or four inches per week of water, respectively.

A slower-moving rig, perhaps at two revolutions per day, would lay down 0.15, 0.22, 0.3 inches per revolution. Testing would determine the most suitable rate and optimum design of the equipment.

The light application of water to any one acre in a given eight or twelve-hour period, coupled with the low daily rates and resting periods between applications, would provide a constantly aerated zone and a water table close to the artificial drain tile level for the two, three, and four-inch weekly rates.

The storage capacity of 0.15 to 0.2 inch per inch would provide for protection against rainstorm runoff to a degree, because the fields would not be saturated from irrigation. In addition, the continuous vegetative covering provides high detention characteristics

and surface storage. This, coupled with border areas designed for overland flow land treatment, is expected to prevent surface runoff for six-hour storms having a frequency of occurrence of approximately once in 25 years. See Figure V-3.

The balance between the use of center-pivot rigs and solid-set sprinklers is flexible, and would be selected after significant early-action testing.

Nitrogen Applications. Nitrogen requirements for production of high-quality Reed canary grass hay having a protein content of above 20 per cent are large.[5] An annual rate of effluent application of 120 inches would be needed to supply the nitrogen requirements, assuming a total N of 16.4 mg/l is available in the municipal/industrial, combined and separate storm runoff. Smaller amounts would require supplemental N. Greater applications could be made without causing excessive nitrate levels in the drainage water.

With a 16.4 mg/l concentration of N (Table V-1), applications of 60, 90, and 120 inches of effluent per year would contain 223, 334, and 446 pounds of N per acre, respectively. The Campbell Soup Report indicated a nitrogen content of high protein Reed canary grass hay as 62 pounds per ton.[4] A yield of four tons per acre would remove 248 pounds of N per acre. Assuming 60 per cent nitrogen uptake efficiency (probably high for such high N levels), the total nitrogen requirement would be 413 pounds per acre. Application of 120 inches of effluent per year would supply the requirement. A supplement of 79 pounds per

acre of N would be needed at 90 inches per year. A supplement of 190 pounds per acre of N would be needed for 60 inches per year. (Figure V-2)

The application of 120 inches of effluent per year would be the optimum rate for recycling nitrogen. The drainage outflow would be of better quality than required. The drainage outflow would be of better quality than required. Considerably higher rates could be more cost-efficient under a disposal concept in which renovation of the effluent is the prime concern.

Crop Utilization. An investigation of the meat packing industry in Sandusky, Ohio and environs indicated two hog meat packing plants and one cattle meat packing company. The Routh Packing Company has a throughput of 10,000 hogs a week, or about 520,000 per year. According to Mr. Richard Kurt of the plant, approximately 35 per cent come from Ohio, 20 to 30 per cent from Indiana, and the rest from Illinois, Iowa, and Missouri. Mr. Kurt did indicate a trend for packing houses to be close to the highest concentrations of production. In other words, most of the hogs are killed in Iowa and Nebraska where they are produced, because of shipping costs. Northern Ohio is a meat importer, and this is reflected in Cleveland area meat prices.[11]

Another company in Sandusky, the Waldock Packing Company, kills approximately 10,000 to 20,000 hogs a day, the livestock coming from local sources which are limited.[12]

The Sandusky Dressed Beef Company is a cattle processor with a kill rate of about 300 head per day, or about 110,000 per year. About

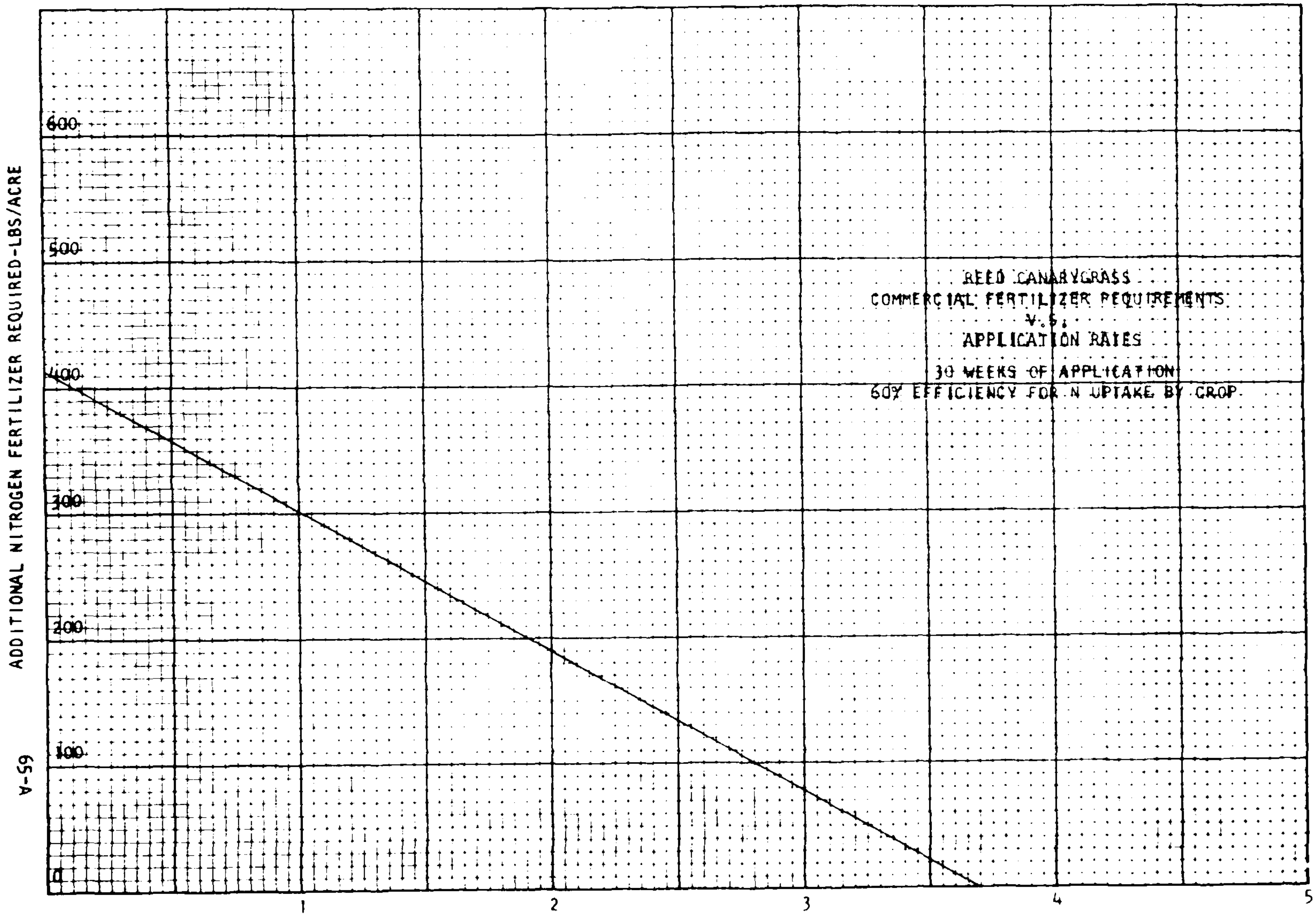

REED CANARYGRASS
COMMERCIAL FERTILIZER REQUIREMENTS
V.S.
APPLICATION RATES
30 WEEKS OF APPLICATION
60% EFFICIENCY FOR N UPTAKE BY CROP
ADDITIONAL NITROGEN FERTILIZER REQUIRED-LBS/ACRE
600
500
400
300
200
100
0
1
2
3
4
5
APPLICATION RATE - INCHES/WEEK

FIGURE V-2

60 per cent of the cattle come from Ohio and the rest from nearby states. Shipping c ,ts affect the plant economics.[13]

Mr. Dean Triplett of Weisbart and Company, of Brush, Colorado, indicated the following typical ration for hogs:

> 70 per cent corn (wheat and milo can be substituted depending on price).
>
> 15 per cent soybean oil and meat scraps consisting of one-fourth meat scraps.
>
> 10 per cent other grains.
>
> 5 per cent minerals and additives.

Experiments for hogs have been made pelletizing roughages such as Reed canary grass with varying degrees of success. However, the pelletized roughages are best for cattle or other animals with similar digestive systems. The value of the feed is, in essence, a matter of cost per calorie, thus the energy per pound of feed would be an impor ant consideration.[14] Calories are related to protein content.

The nutritional quality of Reed canary grass varies widely, depending upon the nitrogen availability in the soil where it is grown. Studies show that Reed canary grass grown on land treatment sites can have exceptional nutritional value, ranging up to 23 per cent crude protein. The mineral content is also high, nearly double the quantity found in other good quality hay. Cattle have exhibited a definite preference for hay grown on land treatment sites.[4]

The following table presents contents of various plant nutrients and digestible constituents for different varieties of animal feed.[4]

TABLE V-8

NUTRITIONAL ANALYSES OF SELECTED ANIMAL FEEDS
(Reference No. 4, Page 15)

Dry Roughage	Protein %	Fiber %	TDN* %	Phos. %	Nit. %	Dry Matter %
Alfalfa hay	14.7	29.0	50.3	.21	2.35	90.4
Bermuda grass hay	7.3	25.6	43.0	.20	1.17	90.7
Clover hay	12.0	27.1	49.0	.23	1.92	89.0
Johnson grass hay	6.5	20.4	50.3	.26	1.04	90.1
Prairie hay	5.7	30.3	49.2	.10	.91	90.4
Reed canary hay	7.5	29.1	46.6	.23	1.20	90.8
Timothy hay	6.2	30.1	46.9	.16	.99	88.7

*Total digestible nutrients

Studies indicate that Reed canary hay can equal or exceed the nutritional value of alfalfa and clover hay, and feeding tests indicate a superior potential market value when compared with other good quality hay.

In the table below, the fodder analysis data from the Paris, Texas land treatment area are presented for comparison with information in Table V-8.

TABLE V-9

NUTRITIONAL AND CHEMICAL ANALYSIS
OF
REED CANARY HAY SAMPLES
(Reference No. 4, Page 17)

Harvest Date	Sample No.	Growth Units	Protein %	Fiber %	TDN* %	Phos. %	Nit. %	Dry Matter %
5/ 2/68	S- 1	1122	21.6	24.4	61.7	0.5	3.7	89.8
5/ 9/68	S- 2	1300	14.7	28.7	54.1	0.6	2.4	89.5
5/16/68	S- 3	1549	16.6	27.4	57.3	0.5	2.7	90.6
5/23/68	S- 4	1721	19.8	29.3	55.7	0.6	3.1	90.2
7/ 1/68	S- 6	3508	22.2	27.7	61.6	0.4	3.6	93.4
7/22/68	S- 9	4615	16.4	30.3	56.5	0.4	2.6	93.5
8/12/68	S-12	5786	16.3	27.6	59.6	0.3	2.6	93.6
9/ 3/68	S-15	6844	18.1	27.0	60.5	0.5	2.9	93.1
9/23/68	S-18	7505	18.8	28.3	59.0	0.6	3.1	92.7
10/ 7/68	S-19	7845	22.0	25.0	64.2	0.5	3.6	93.2
10/28/68	S-22	8270	23.0	24.2	65.5	0.6	3.7	93.2

*Total Digestible Nutrients

"It is a well-established agricultural fact that when an excess of nutrient elements are present in the soil, plants will uptake in greater quantity than normal. In wastewater disposal, this phenomenon is of special significance in that those plant nutrients removed in the hay are totally unavailable for algae growth in the receiving stream. The phosphorus thus removed amounts to ten pounds of P per ton of hay, or 8,000 pounds removed in a single cutting of 32,000 bales in Paris in 1968 (24,000 lbs. of PO_4). Even more impressive is the uptake of nitrogen which averages 3.1 per cent of dry weight of the Reed Canary hay or 62 lbs. per ton -- nearly 50,000 lbs. of N removed in the single harvest of 1968."[4] (Page 17)

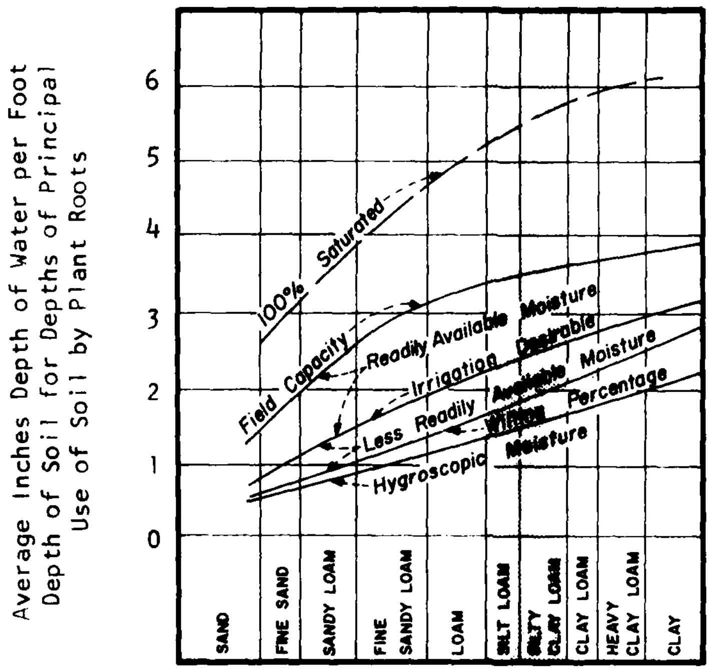
The growing of Reed canary grass on the western land treatment site could form the basis for the development of a major local industry related to cattle feeding and slaughtering. Waste products (manure) from the cattle could be returned to the agricultural land, helping to make up the nitrogen demands of the hay crop. Waste from the slaughtering operations would also lend itself to land treatment. Thus, recycling potential could be compounded significantly by subsystem nutrient uses.

With hogs and cattle being shipped in from other states at present, a local cattle-raising industry could reduce the national and regional transportation demands somewhat, and tend to reduce meat prices for those who are economically disadvantaged in the Cleveland area.

This sample description of irrigation management on the Cardington-Bennington soils for application rates of from 60 to 120 inches per year provides for a wide range of choices in hydraulic loading. Costing of land treatment in western Ohio is based on 70 per cent of the land being irrigated at 75 inches per year, 25 per cent at 50 inches, and five per cent at 90 inches per year. Furtner analyses are expected to point towards the use of higher application rates; however, this can be a decision made at a later time in the project development.

FIGURE V-3

APPROXIMATION OF SOIL MOISTURE AND STORAGE CAPACITY FOR CARDINGTON - BENNINGTON SOILS



The above figure corresponds to Figure No. 2 on Page 19 of Reference No. 15, except for the dashed line representing saturated conditions, which was calculated using an equation and values given by the same author for different soils.

SATURATED CONDITIONS

	Vm (Per Cent Moisture by Volume)	Inches of Water per Foot of Soil (Equal to 0.12 Vm)
Sandy Soil	20	2.4
Most Cultivated Soils	30 - 50	3.6 - 6.0
Clay	> 50	> 6.0

Before irrigation, the "A" horizon would normally have a moisture content of less than field capacity. If it is assumed that the available moisture (the difference between the wilting point and field capacity) is 25 per cent depleted prior to irrigation, the available storage for a

silty clay loam, such as a Cardington or Bennington soil, can be estimated, using Figure No. V-3 as follows:

	Inches of Water per Foot of Cardington-Bennington Soil
At 100 per cent saturation	5.5 inches/foot
At 75 per cent field capacity	3.4 inches/foot
Available Storage Capacity	2.1 inches/foot (0.175 inches/inch)

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SECTION VI

COST ESTIMATION METHODOLOGY FOR RANGE OF ALTERNATIVES

GENERAL

An essential task of the Survey Scope Study was to provide the basis for a cost comparison of the numerous alternative plans developed during the earlier stages of the study. In addition, the final alternatives have been construction-phased and fully costed, as described under that portion of the report dealing with final alternatives.

The cost estimates were to be prepared and presented in such a way as to permit not only comparisons among the plans, but also identification of the costs of the various major components of each plan, e. g., sewers, treatment plants, pumps, and reservoirs, and a separation of the costs related to treating stormwater from the costs of treating municipal and industrial wastewaters in each plan. The cost figures to be used for these three purposes were to incorporate both construction costs (capital costs) and the costs of operating and maintaining the systems after construction (O & M costs).

INITIAL COSTING FOR COMPARABILITY

The need for an initial cost comparability among plans led to the adoption of a standardized procedure for design work and cost estimation for this early work. First, each plan was laid out to meet projected wastewater loads for the year 2020. Second, the

costing procedure assumed that the 2020 facilities would be built at one time using current (1972) costs. Third, the total capital cost for each component of the wastewater treatment system would be converted to an annual payment based on a 7 per cent interest rate amortized over the estimated useful life of the particular component. The replacement cost for each component was incorporated in this annual capital cost payment by use of a capital recovery factor related to the component's estimated useful life. Finally, the annual capital cost for each component of the plan was added to the annual operation and maintenance (O & M) cost and this total represents the "annual comparable cost" for that particular component of the plan.

In order to facilitate comparisons among plans, a single "annual comparable cost" for each plan was needed. This was accomplished by totaling separately the capital costs and the O & M costs of the individual components and then adding a uniform contingency factor of 30 per cent (including 5 per cent for engineering and design and 5 per cent for supervision and administration) to the total annual capital cost, and a 20 per cent contingency factor to the total annual O & M cost for each plan. The sum of these two figures was the plan's annual comparable cost.

Finally, it was desired to isolate the costs of treating stormwater. Where actual facilities for transmission, storage, and treatment of stormwater were completely separate from the municipal-industrial sewage treatment systems, the costs could be totaled

directly. However, many of the facilities in the twelve plans were designed to combine stormwater and municipal wastewater at varying points in the treatment system, and in these cases, it was necessary to subtract an increment of cost from each component in proportion to the additional capacity required for the inclusion of stormwater.

This "stormwater increment" for both Capital and O & M costs was then added to the costs for the separate stormwater facilities, to obtain a total annual comparable cost for stormwater treatment in each plan. These computations all are shown in Tables 1-C through 12-C in the Formulation Technical Appendix - Development of Twelve Alternative Plans.

The development of annual comparable costs described above assumes that the wastewater treatment systems in each plan can be broken down into separate components or cost items, for which capital and O & M costs can be calculated. Since the same general components are used in all plans, but in varying combinations and sizes, it was possible to set up a standardized table for detailed cost computations, in which each column represented a separate cost item. Samples of these land treatment cost computations for Plans 12 and 7, including both capital and O & M costs, are presented at the end of this section, and three schematic diagrams are included to illustrate the cost items corresponding to each column. In these tables and diagrams, Item Nos. 7 through 11 correspond to collection and conventional in-plant treatment facilities and were designed and cost estimated by

Havens and Emerson, Ltd. of Cleveland. However, where aerated lagoons are utilized in land treatment they are also assigned a column (plant) number and the cost figures for the aerated lagoon component are shown in this column when and where applicable. The remaining components, 13 through 29, are related only to systems incorporating land treatment and were designed and costed by Wright-McLaughlin Engineers of Denver. It should be noted that Sludge Management, except by incineration, was also costed by Wright-McLaughlin and used in those plans which are otherwise full or partially water-based treatment as costed by Havens and Emerson, Ltd.

CAPITAL COSTS

The basic element in this costing system is the cost per unit of measurement, or the unit cost. After each plan was broken down into a number of components (i. e., Storage Reservoirs), each component was then analyzed and the cost of its construction was expressed in terms of a unit of measurement related to that component (i. e., the cost per million gallons of storage capacity in a Storage Reservoir). Thus, the estimated total cost of a component within a particular plan might be obtained by multiplying the cost determined for each unit by the number of units called for in that plan.

It is important to note that the unit of measurement is common to components performing the same function in any plan (i. e., million gallons of storage); however, the cost per unit of measurement (cost per million gallons of storage) could vary widely, depending upon the

relative size of a particular component as utilized in a particular plan, according to economies of scale. These relationships are expressed in cost curves presented at the end of this section, and a table entitled Summary of Unit Capital Costs relates the use of these curves to the calculation of the capital cost for each component.

This system enables planners to compare the costs of the components, or groups of components, performing similar functions. It also allows them to estimate the total cost of performing any one function in a given plan. Finally, it makes possible a cost comparison for performing similar functions with different plans.

OPERATION AND MAINTENANCE COSTS

Operation and maintenance unit costs in some cases were based on the computed capital costs for land treatment components, and in other cases, were directly related to design units such as acres or million gallons, etc., rather than to capital costs.

To establish a particular O & M unit cost, a composite labor and materials estimate was made with a separate estimate being made for power, where applicable.

LAND COSTS

Costs for land acquisition were based on information provided by the Real Estate Division of the North Central Divisional Office, Corps of Engineers, Chicago, Illinois. With an acquisition cost of $16,000 for one unit of farm buildings, and an average relocation cost of $5,000 per family, the total cost per acre, including the cost of the land,

averaged $600. The 15 per cent variation allowance previously added by the Real Estate Division in their calculation was included in the overall 30 per cent contingency applied to the capital costs. While the resultant average cost of $780 per acre is slightly higher than the $700 indicated by the Real Estate Division, the new cost appears to be a reasonable estimate in view of the wide variations in land cost by counties and the generally rising trends in the real estate market.

The Real Estate Division office specifically requested that the following limiting condition be set forth in any report incorporating their land cost estimate: "The estimate listed herein is not based upon appraisals; therefore, the prices are estimates only. In addition, the cost for farm buildings to be acquired can vary greatly, depending upon the areas selected, and until a firm plan is available, no definite amounts can be given."

SOURCES OF COSTING INFORMATION

In addition to the accumulated costing experience of Wright-McLaughlin, Havens and Emerson, and AWARE, a number of other organizations were consulted to obtain as broad a base as possible for costing the twelve alternative wastewater management plans. Cost data from actual contract bids is, of course, the preferred source of costing information, and such actual unit costs were used as a basis wherever practical. Governmental agencies, such as the U. S. Bureau of Reclamation, played an important role in providing information. The Corps of Engineers supplied special research material prepared under

contract, such as the "CRREL Report", and compiled resource material and cost curves for consultants engaged in pilot studies currently underway. The Environmental Protection Agency, and other agencies directly concerned with wastewater management, prepared background studies and prototype environmental impact statements. Other sources of information included the consulting firms of Bauer Engineering, Inc. and Woodward-Clevenger Associates, Inc., university personnel, and manufacturers.

The specific references for each land treatment unit cost are contained in a technical submittal entitled "Unit Costs", submitted on September 22, 1972 and revised on October 6, 1972. (See Attachment A)

LAND TREATMENT

SEQUENCE OF COST COMPONENTS *
OF FORMULATED PLANS

Initial Treatment	In-Basin
Final Treatment	In-Basin

* Circled Numbers Refer To Column Numbers On Detailed Cost Sheets

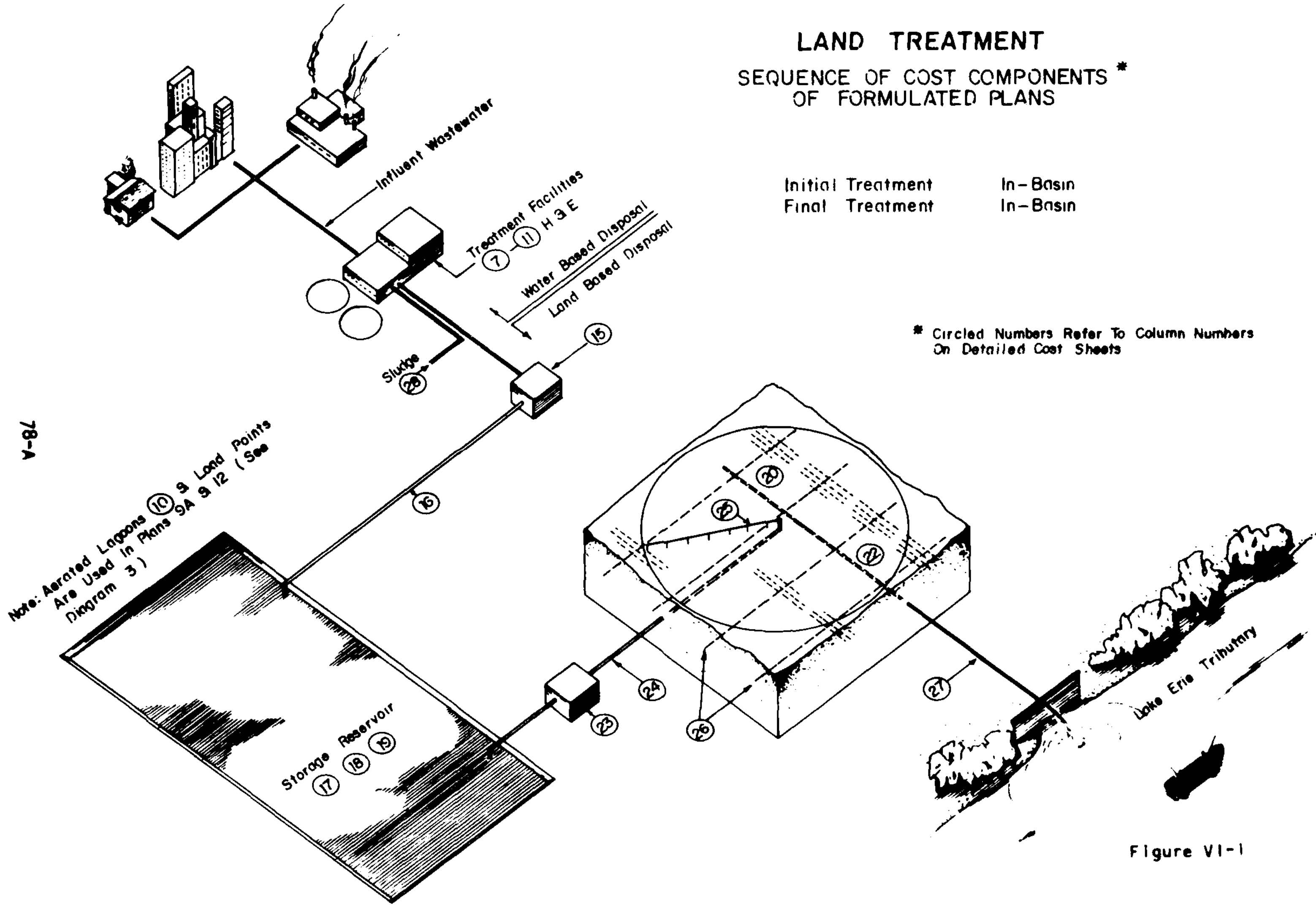


Figure VI-1

LAND TREATMENT

SEQUENCE OF COST COMPONENTS *
OF FORMULATED PLANS

Initial Treatment — In-Basin
Final Treatment — Out-of-Basin

* Circled Numbers Refer To Column Numbers On Detailed Cost Sheets

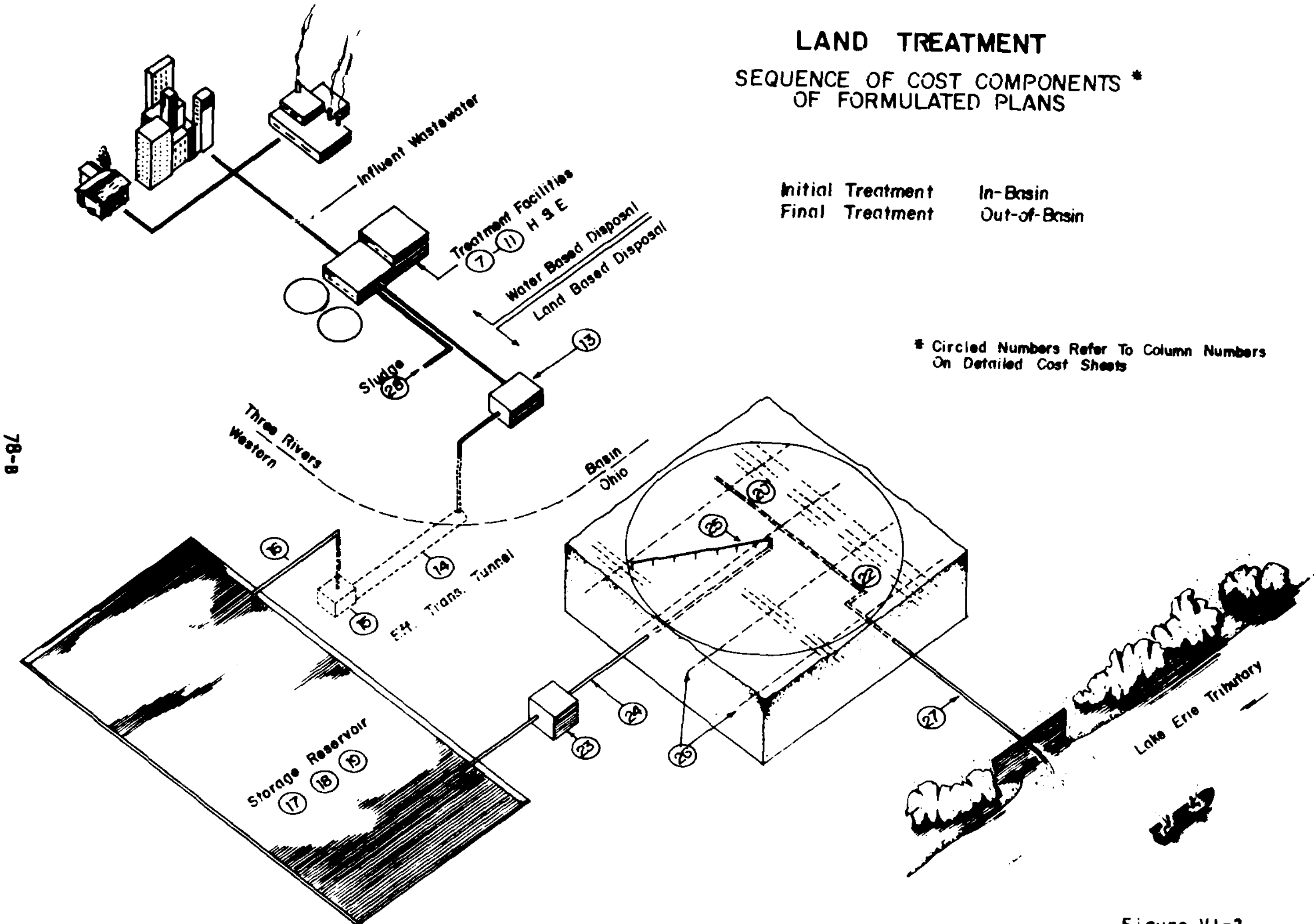


Figure VI-2

LAND TREATMENT
SEQUENCE OF COST COMPONENTS* OF FORMULATED PLANS

Initial Treatment — Out-of-Basin
Final Treatment — Out-of-Basin

* Circled Numbers Refer To Column Numbers On Detailed Cost Sheets

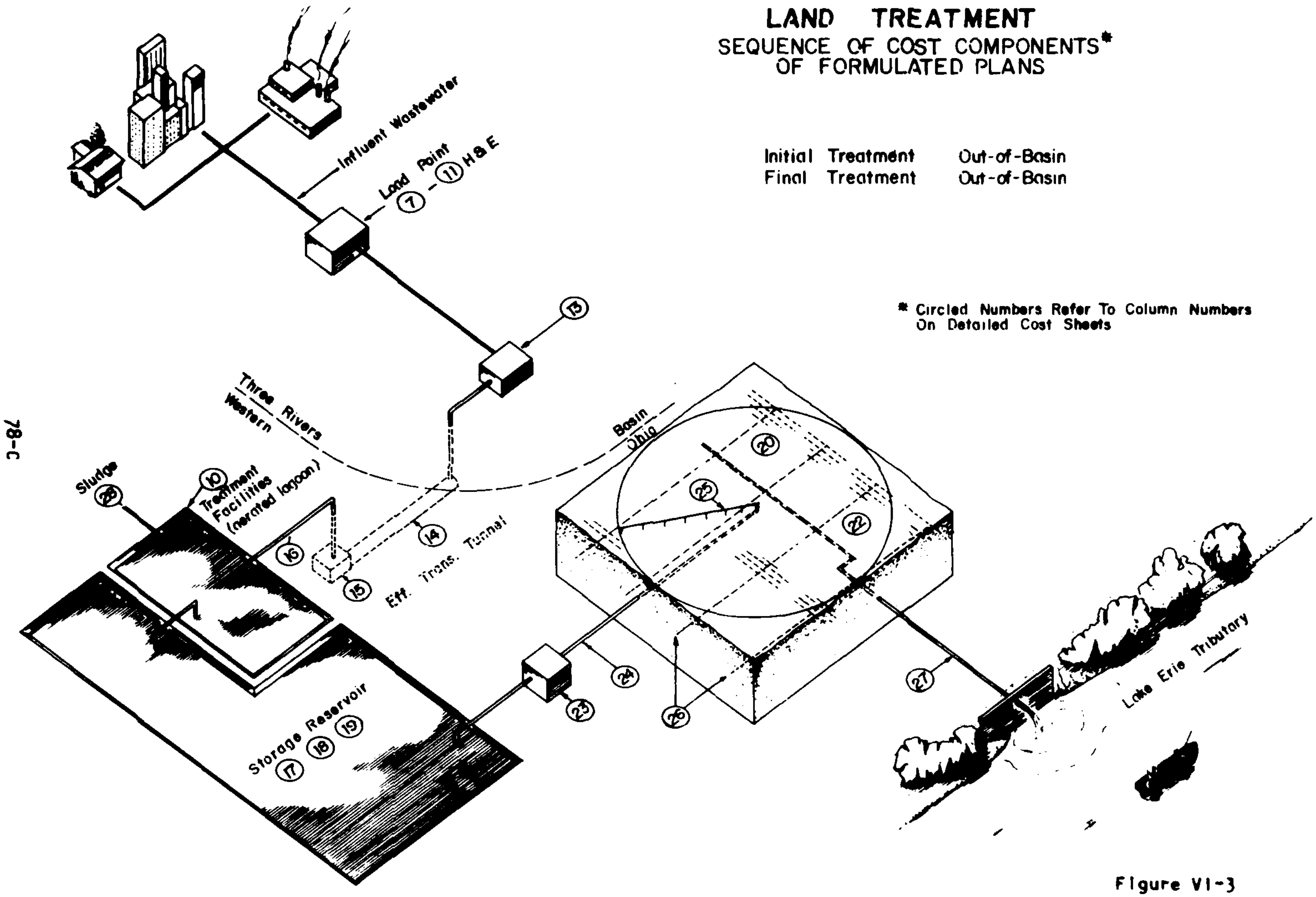


Figure VI-3

TABLE VI-1
LAND TREATMENT
SUMMARY OF UNIT CAPITAL COSTS
FOR FORMULATED PLANS

DETAILED COST SHEET COL. NO.	ITEM OR COST COMPONENT	UNIT USED	COST PER UNIT	REMARKS
1	Plant Name	--	--	
BASIC DESIGN DATA				
2	Detention Storage	MG	Data Used in Component Costing	
3	Plant Capacity	MGD	Data Used in Component Costing	
4	Raw Sludge	TPD	Data Used in Component Costing	
5	Winter Storage	MG	Data Used in Component Costing	
6	Land Treatment Site	Acre	Data Used in Component Costing	
PRE-TREATMENT FACILITIES				
7	Detention Storage	(H&E)	(Costed by H&E)	
8	Sewers	(H&E)	(Costed by H&E)	
9	Pump Station	(H&E)	(Costed by H&E)	
10	Plant: Conventional Secondary Aerated Lagoon	(H&E)	(Costed by H&E)	
10A	Prelim. Treatment	(H&E)	(Costed by H&E)	
10B	Lagoon System	MGD	Varies - Use W-ME Curve G	
10C	Disinfection	MGD	Varies - Use W-ME Curve H	Use Total ADF
11	Sludge	(H&E)	(Costed by H&E)	
12	Total Columns 7-11	--	--	
TRANSMISSION FACILITIES				
13	Pump Plant (Force Main to Tunnel)	MGD	Varies - Use W-ME Curve A	Use Plant Factor to Adjust ADF for Peak Flows
14	Tunnel Complex:			
	Force Main (To Drop Shaft)	Foot	Varies - Use W-ME Curve D	Sized for Peak Flows
	Drop Shaft	Foot	Varies - Use W-ME Curve C	Sized for Peak Flows
	Tunnel	Foot	Varies - Use W-ME Curve B	Sized for Peak Flows
	Lift Shaft	Foot	Varies - Use W-ME Curve C	Sized for Peak Flows

TABLE VI-1 (Continued)
LAND TREATMENT
SUMMARY OF UNIT CAPITAL COSTS
FOR FORMULATED PLANS

DETAILED COST SHEET COL. NO.	ITEM OR COST COMPONENT	UNIT USED	COST PER UNIT	REMARKS
TRANSMISSION FACILITIES (Continued)				
15	Secondary Pump Plant (To Storage Reservoir)			
	From Plant	MGD	Varies - Use W-ME Curve A	Use Plant Factor to Adjust ADF for Peak Flows
	Out of Tunnel	MGD	Varies - Use W-ME Curve E	Use Average Max. Daily Sanitary + Average Daily Stormwater Flow
16	Force Main (To Storage Res.)	Foot	Varies - Use W-ME Curve D	Sized for Peak Flows
STORAGE RESERVOIR				
17	Reservoir	MG	Varies - Use W-ME Curve F	Length of Application Period Determines Storage Capacity
18	Aeration	MG	$700	
19	Disinfection	MGD	Varies - Use W-ME Curve H	Length of Application Period Determines Daily Flow
LAND TREATMENT SITE				
20	Purchase & Relocation	Acre	$600	
21	--	--	--	
22	Site Preparation	Acre	$65	Specialized Preparation Included in Irrigation Equipment
IRRIGATION SYSTEM				
23	Pump Station	MGD	Varies - Use W-ME Curve I	Capacity 1.5 x Application Period Daily Average Flow for Peaking
24	Force Main (Reservoir to Site)	Foot	Varies - Use W-ME Curve D	Sized for Peak Flows
25	Equipment & Distribution Piping	Acre	Varies from $175 to $475	According to Soil Association Being Irrigated

TABLE VI-1 (Continued)
LAND TREATMENT
SUMMARY OF UNIT CAPITAL COSTS
FOR FORMULATED PLANS

DETAILED COST SHEET COL. NO.	ITEM OR COST COMPONENT	UNIT USED	COST PER UNIT	REMARKS
DRAINAGE SYSTEM				
26	Tile	Acre	Varies from $350 to $495	According to Soil Association Being Drained
27	Conduits & Canals	Acre	$25	As Needed to Convey Return Flow to Suitable Discharge Points
SLUDGE MANAGEMENT FACILITIES				
28	Sludge Management			
	Aer. Lagoons to Agric.Land	Ton	$120	
	Conv. Plants to Agric.Land	Gallon	Varies - Use W-ME Curve K	
	Plants & Lagoons to Strip Mine Land	Ton	Varies - Use W-ME Curve L	
MISCELLANEOUS				
29	Monitoring, Admin. Buildings & Laboratories	Percent	5 Percent of Irrigation System + Drainage System Total Capital Costs	

TABLE VI-2
LAND TREATMENT
SUMMARY OF UNIT O & M COSTS
FOR FORMULATED PLANS

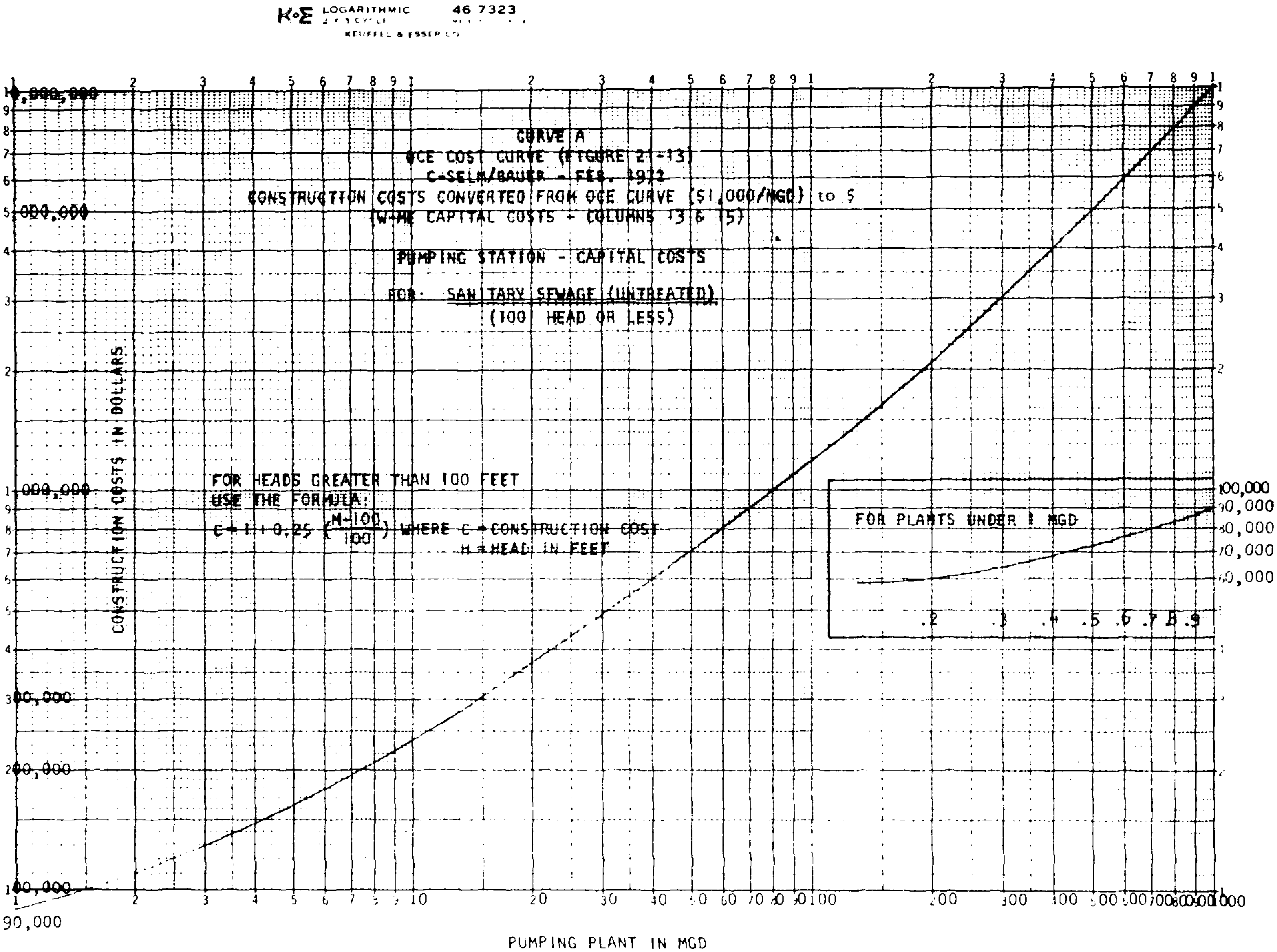
DETAILED COST SHEET COL. NO.	ITEM OR COST COMPONENT	UNIT USED	COST PER UNIT	REMARKS
1	Plant Name	--	--	
BASIC DESIGN DATA				
2	Detention Storage	MG	Data Used In Component Costing	
3	Plant Capacity	MGD	Data Used In Component Costing	
4	Raw Sludge	TPD	Data Used In Component Costing	
5	Winter Storage	MG	Data Used In Component Costing	
6	Land Treatment Site	Acre	Data Used In Component Costing	
PRE-TREATMENT FACILITIES				
7	Detention Storage	(H&E)	(Costed by H&E)	
8	Sewers	(H&E)	(Costed by H&E)	
9	Pump Station	(H&E)	(Costed by H&E)	
10	Plant: Conventional Secondary Aerated Lagoon	(H&E)	(Costed by H&E)	
10A	Prelim. Treatment	(H&E)	(Costed by H&E)	
10B	Power (Aeration)	MGD	$7,550/year	Use Total ADF
10C	Maint. & Labor	Percent	3 Percent of Lagoon System Capital Cost	
10D	Disinfection			
	(Maint.&Labor)(In-Basin)	MGD	$3,650/year	Use Total ADF. Power Assumed Negligible.
	(Maint.&Labor)(Out-of-Basin)	MGD	$2,500/year	Use Total ADF. Power Assumed Negligible.
11	Sludge	(H&E)	(Costed by H&E)	
12	Total Columns 7-11	--	--	
TRANSMISSION FACILITIES				
13	Pump Plant (Force Main to Tunnel)			
13A	Power	MGD	$2,100/year	Use Total ADF As Adjusted
13B	Maint. & Labor	Percent	5 Percent of Capital Cost	

TABLE VI-2 (Continued)
LAND TREATMENT
SUMMARY OF UNIT O & M COSTS
FOR FORMULATED PLANS

DETAILED COST SHEET COL. NO.	ITEM OR COST COMPONENT	UNIT USED	COST PER UNIT	REMARKS
TRANSMISSION FACILITIES (Continued)				
14	Force Main, Drop Shaft, Tunnel, Lift Shaft			
	Maint. & Labor	Percent	1/2 Percent of Capital Cost	
15	Secondary Pump Plant (To Stor. Reservoir)			
15A	Power (From Plant)	MGD	$5,550/year	Use Total ADF As Adjusted
15A	Power (Out of Tunnel)	MGD	$15,000/year	Use Total ADF As Adjusted
15B	Maint.&Labor (From Plant)	Percent	5 Percent of Capital Cost	
15B	Maint.&Labor (Out of Tunnel)	Percent	3 Percent of Capital Cost	
16	Force Main (To Stor. Res.)			
	Maint. & Labor	*Percent*	*1/2 Percent of Capital Cost*	
STORAGE RESERVOIR				
17	Reservoir - Maint. & Labor	Percent	1/2 Percent of Capital Cost	
18A	Aeration - Power	MG	$20	Use Storage Reservoir Volume
18B	Aeration - Maint. & Labor	MG	$20	Use Storage Reservoir Volume
19A	Disinfection - Power	MGD		Power Assumed Negligible
19B	Disinfection - Maint. & Labor	MGD	$1,825/year	Length of Application Determines Daily Flow
LAND TREATMENT SITE				
20	Purchase & Relocation	--	--	No O & M Cost Incurred
21	--	--	--	--
22	Site Preparation	--	--	No O & M Cost Incurred
IRRIGATION SYSTEM				
23	Pump Station			
23A	Power (In-Basin Wastewater)	Acre	$18/year	
	(In-Basin Stormwater)	Acre	$36/year	
	(Out-of-Basin)	Acre	$16/year	

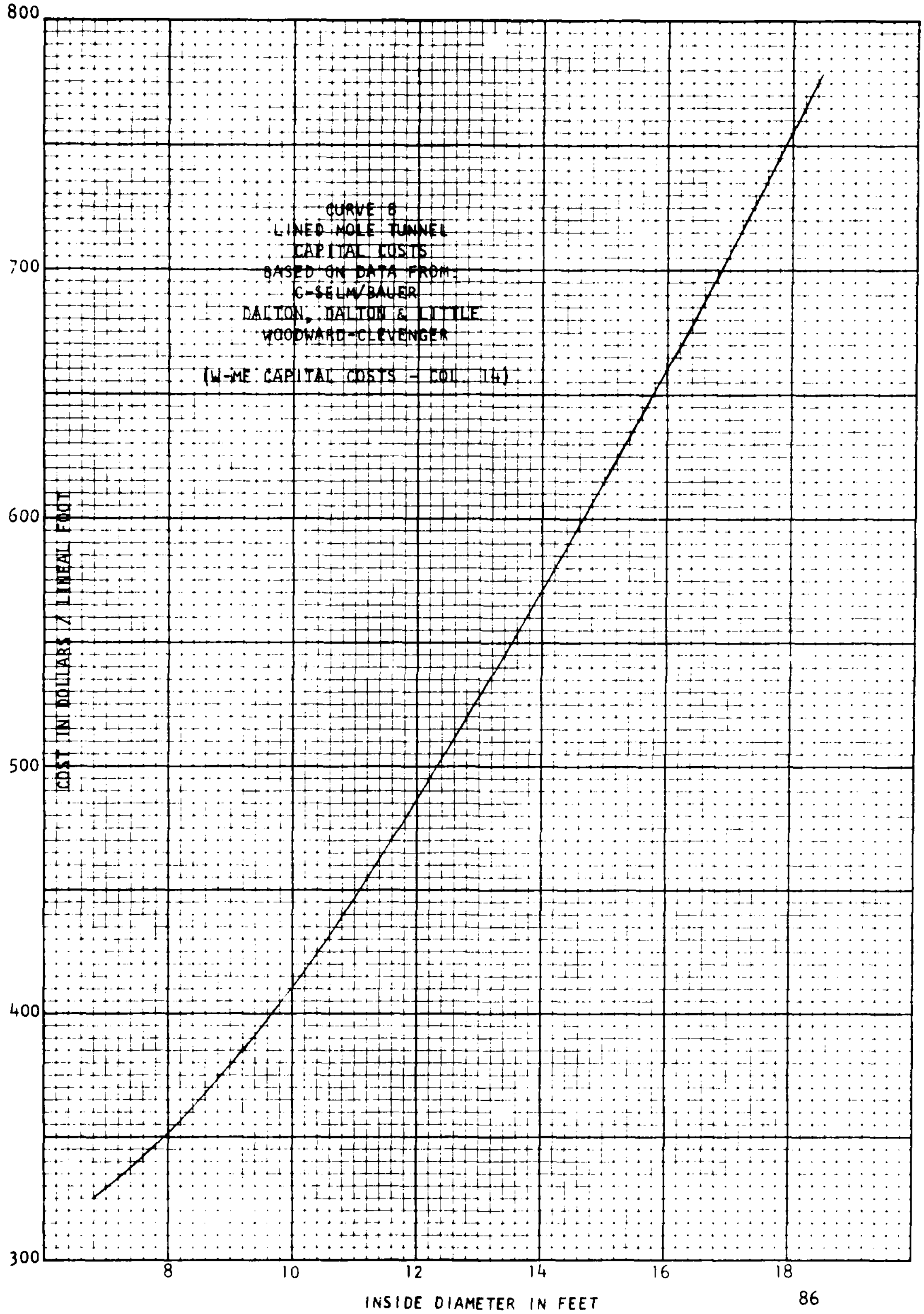
TABLE VI-2 (Continued)
LAND TREATMENT
SUMMARY OF UNIT O & M COSTS
FOR FORMULATED PLANS

DETAILED COST SHEET COL. NO.	ITEM OR COST COMPONENT	UNIT USED	COST PER UNIT	REMARKS
IRRIGATION SYSTEM (Continued)				
	Pump Station			
23B	Maint. & Labor (In-Basin)	Percent	5 Percent of Capital Cost	
	(Out-of-Basin)	Percent	3 Percent of Capital Cost	
24	Force Main - Maint. & Labor	Percent	1/2 Percent of Capital Cost	
25	Equipment & Distribution Piping			
	Maint. & Labor	Acre	$10/year	Using Center Pivot Type Sprinklers
	Maint. & Labor	Acre	$ 4/year	Using Solid Set Sprinklers
DRAINAGE SYSTEM				
26	Tile - Maint. & Labor (In-Basin)	Acre	$ 4/year	
	(Out-of-Basin)	Acre	$ 4.50/year	
27	Conduits & Canals - Maint.&Labor	Acre	$ 2/year	
SLUDGE MANAGEMENT FACILITIES				
28	Sludge Management			Includes Both Power and Maint. & Labor Costs
	Conv.Plant/Agric.Land (In-Basin)	Ton	$40	
	Aer.Lagoons/Agric.Land (In-Basin)	Ton	$16	
	Aer.Lagoons/Agric.Land(Out-of-Basin)	Ton	$16	
	Conv. Plant/Strip Mine Land	Ton	$16	
	Aer. Lagoons/ Strip Mine Land	Ton	$16	
MISCELLANEOUS				
29	Monitoring, Admin. Buildings & Laboratories	Percent	10 Percent of Capital Cost as Computed for Miscellaneous	


K&E LOGARITHMIC 46 7323
KEUFFEL & ESSER CO.
CURVE A
OCE COST CURVE (FIGURE 21-13)
C-SELM/BAUER - FEB. 1972
CONSTRUCTION COSTS CONVERTED FROM OCE CURVE ($1,000/MGD) to $
(W-HE CAPITAL COSTS - COLUMNS 13 & 15)
PUMPING STATION - CAPITAL COSTS
FOR: SANITARY SEWAGE (UNTREATED)
(100 HEAD OR LESS)
FOR HEADS GREATER THAN 100 FEET
USE THE FORMULA:
C = 1 + 0.25 (H-100 / 100) WHERE C = CONSTRUCTION COST
H = HEAD IN FEET
FOR PLANTS UNDER 1 MGD
CONSTRUCTION COSTS IN DOLLARS
PUMPING PLANT IN MGD
1,000,000
500,000
1,000,000
300,000
200,000
100,000
90,000
100,000
90,000
80,000
70,000
60,000

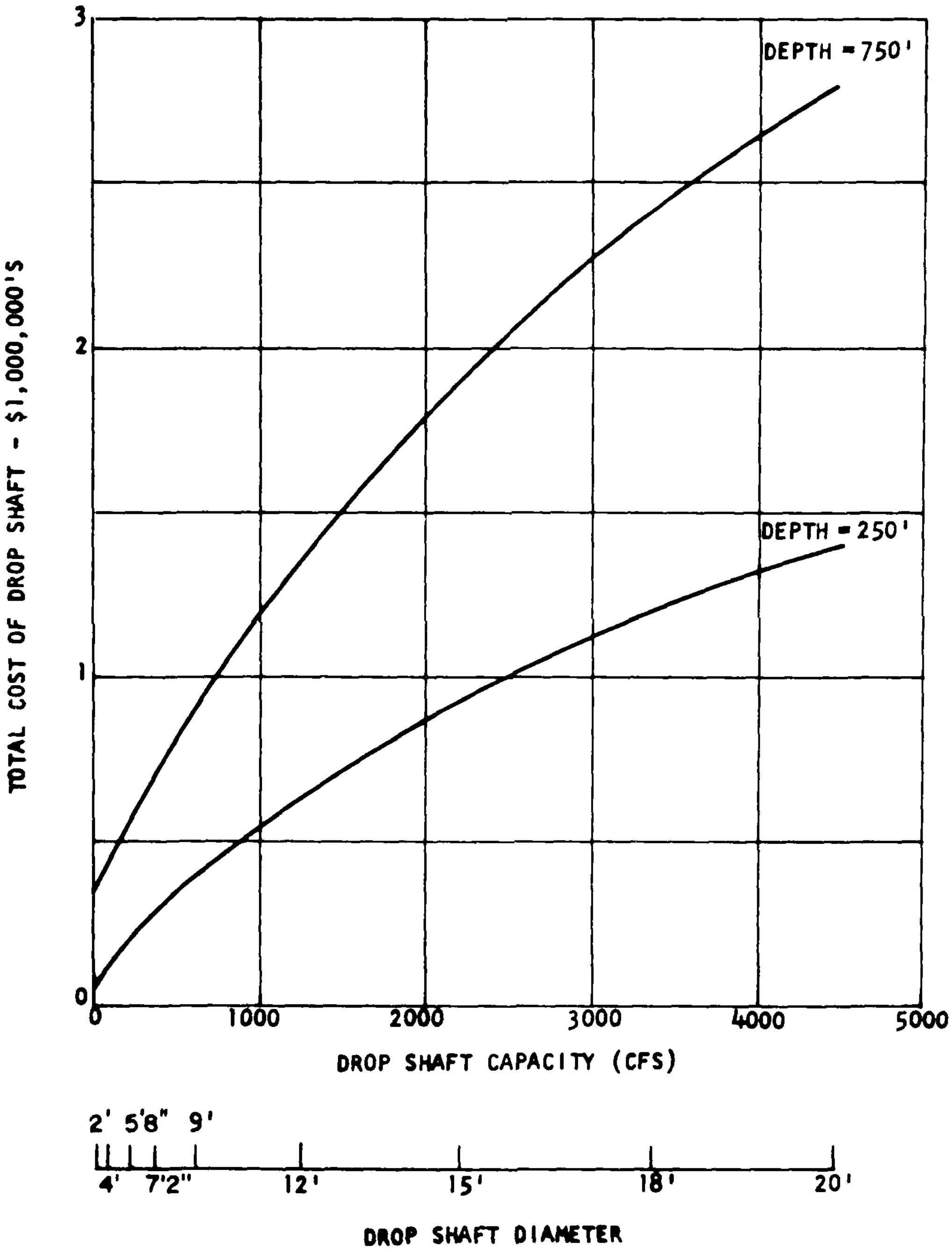
CURVE A

CURVE B

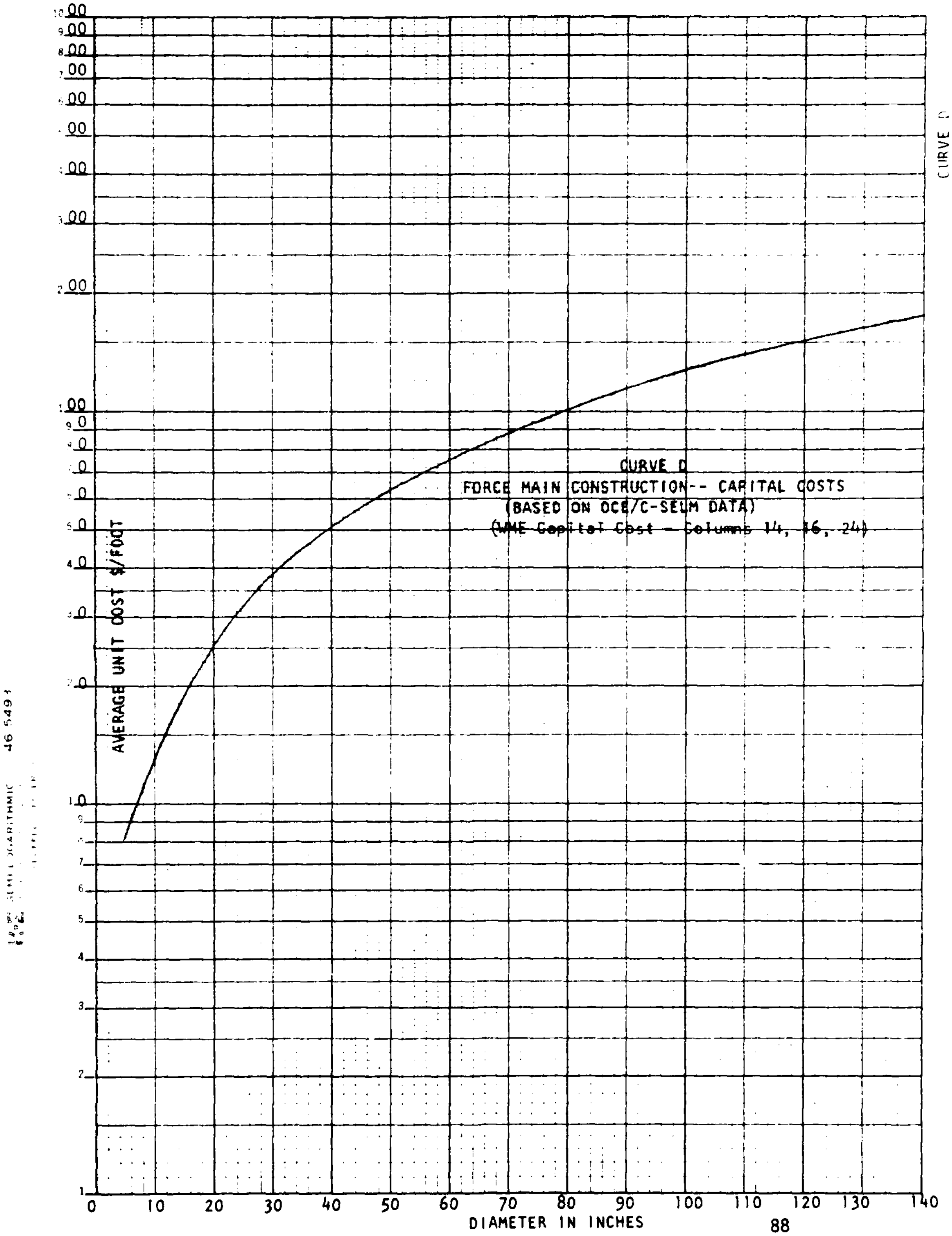


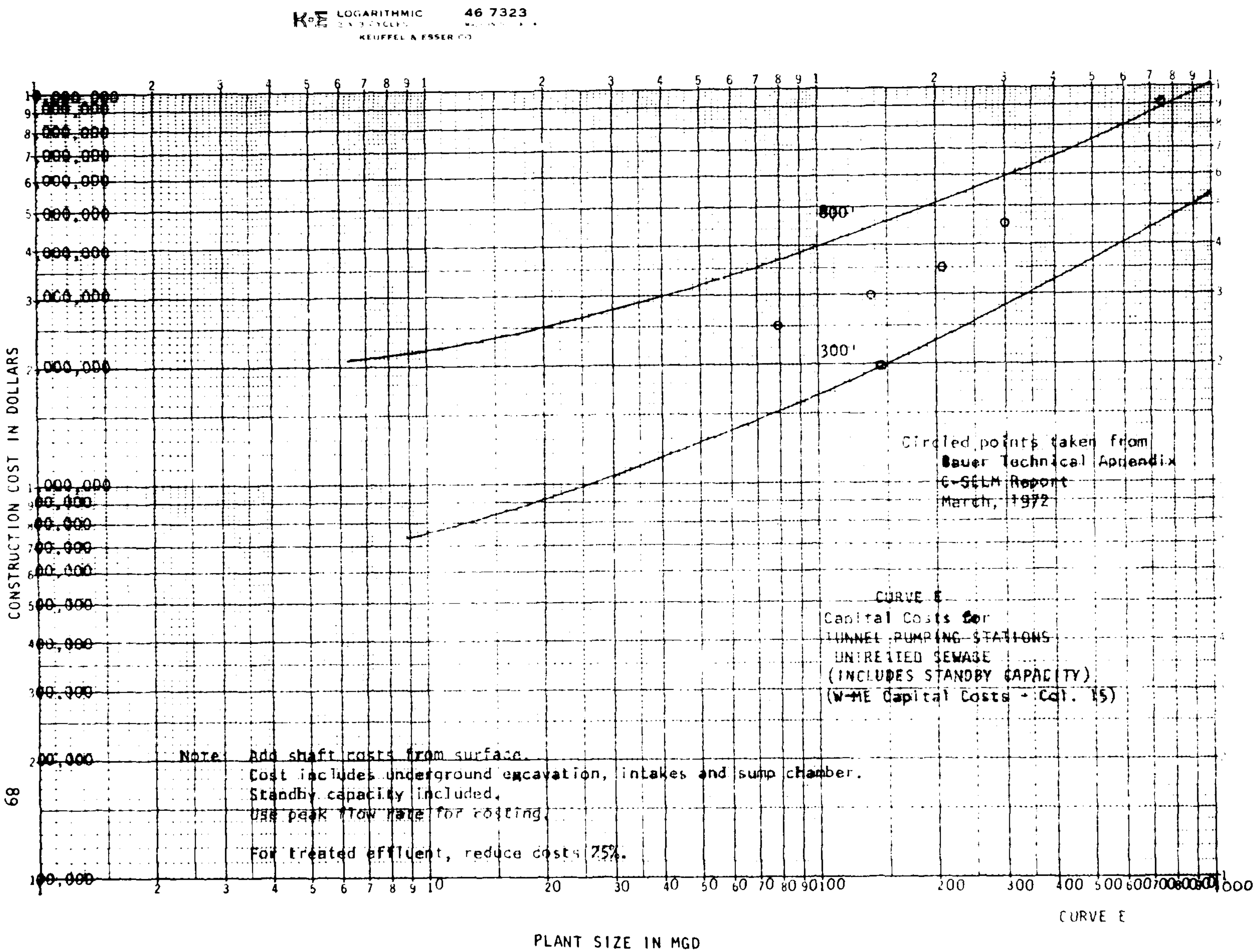
CURVE B
LINED MOLE TUNNEL
CAPITAL COSTS
BASED ON DATA FROM:
C-SELM/BAUER
DALTON, DALTON & LITTLE
WOODWARD-CLEVENGER
(W-ME CAPITAL COSTS - COL. 14)
COST IN DOLLARS / LINEAL FOOT
800
700
600
500
400
300
8
10
12
14
16
18
INSIDE DIAMETER IN FEET

CURVE C
OCE, FIGURE 21-14
C-SELM, BAUER
(WME CAPITAL COSTS - COLS. 14 & 15)
DROP SHAFT CAPACITY VS. TOTAL COST

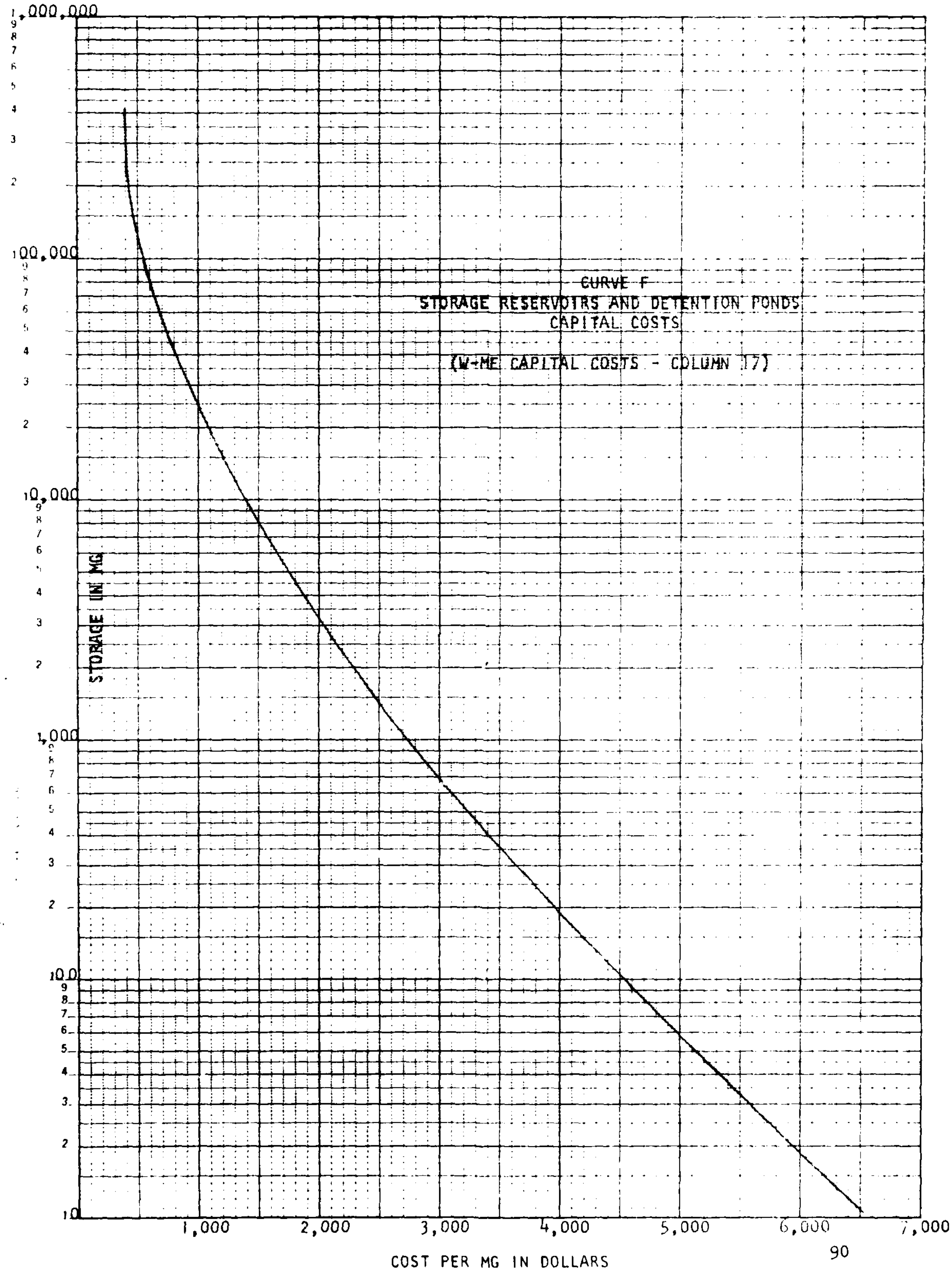


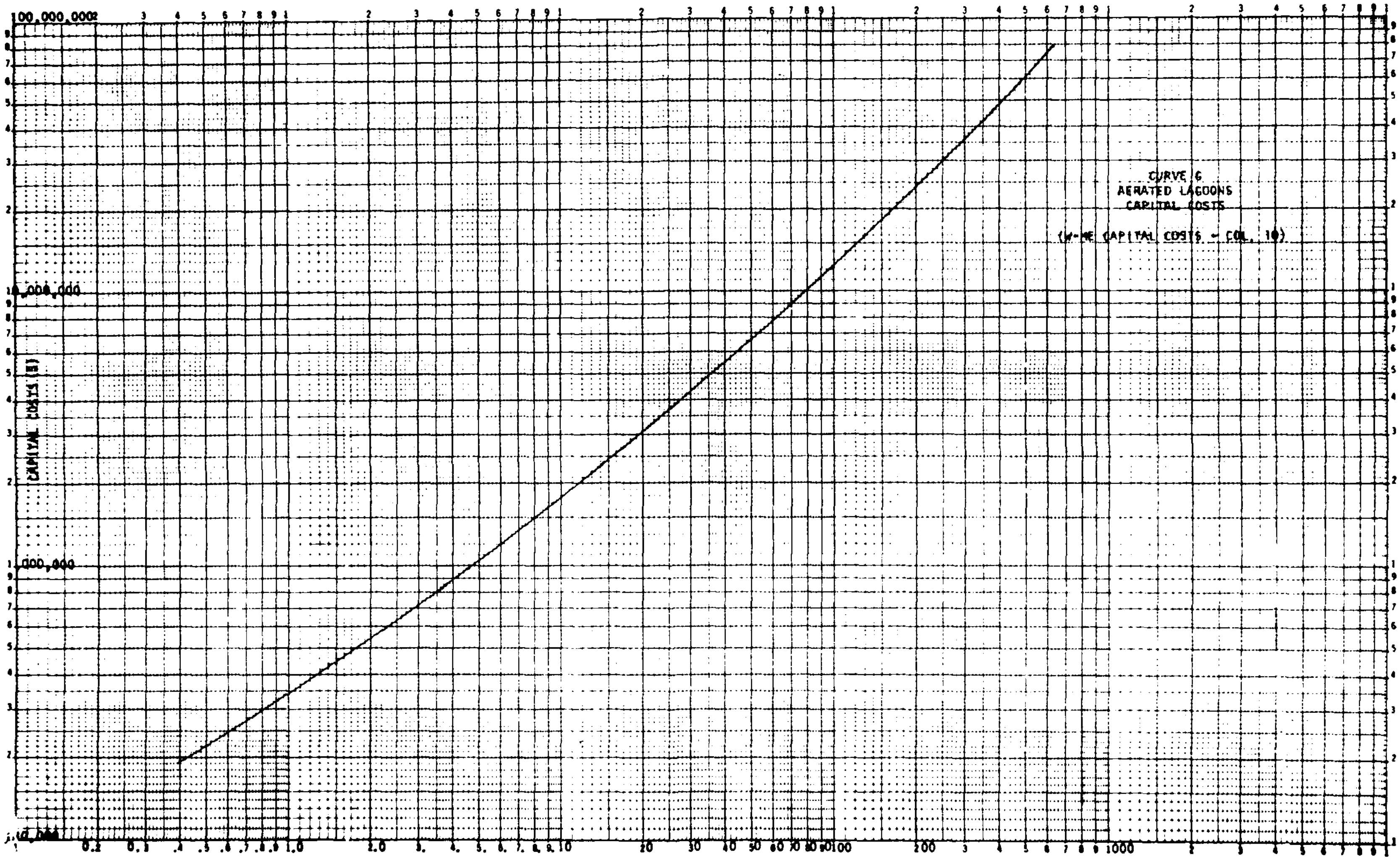
CURVE C


CURVE D
FORCE MAIN CONSTRUCTION-- CAPITAL COSTS
(BASED ON OCE/C-SELM DATA)
~~(WME Capital Cost - Columns 14, 16, 24)~~
AVERAGE UNIT COST $/FOOT
DIAMETER IN INCHES
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
1000
100
10
1
CURVE D

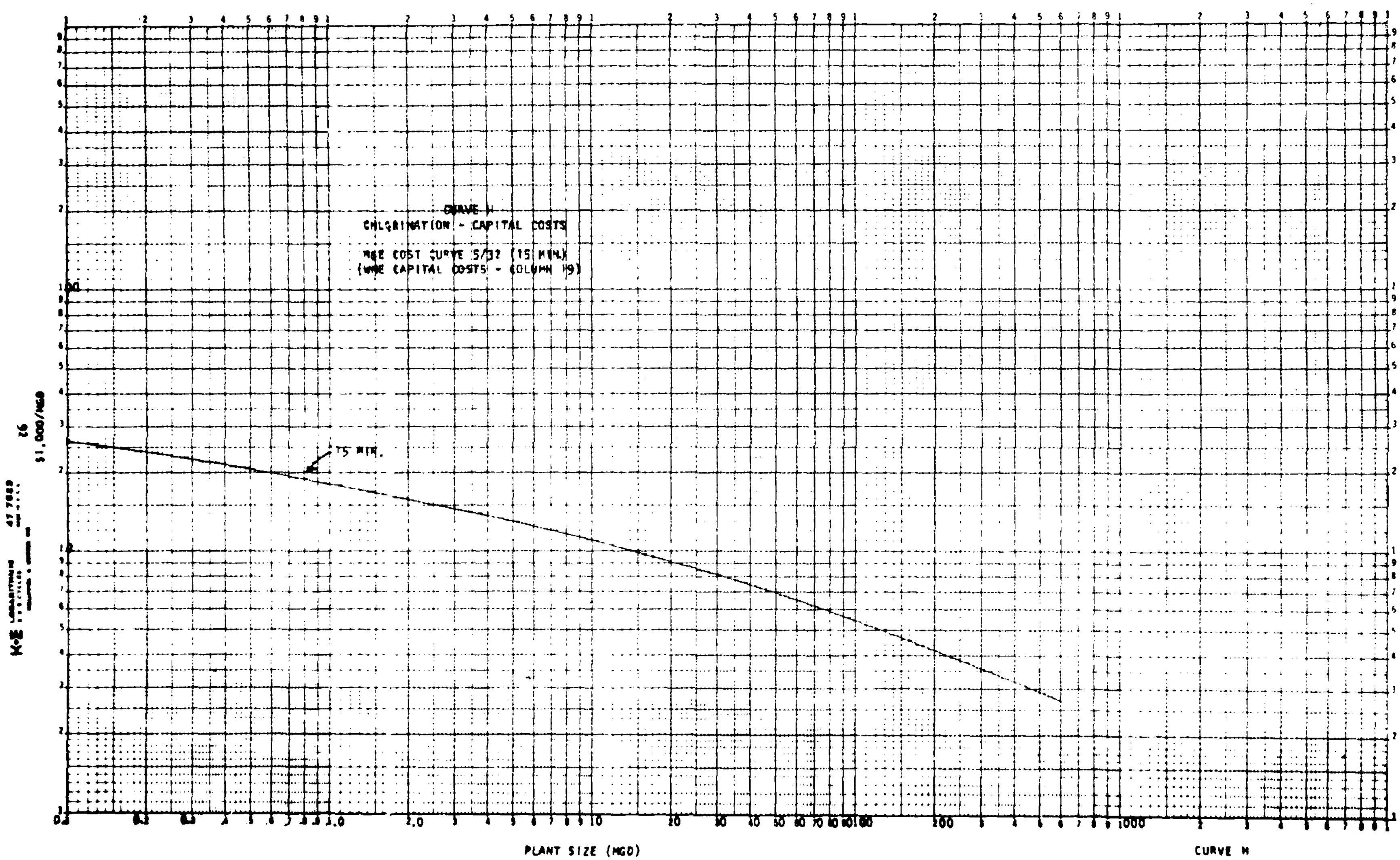


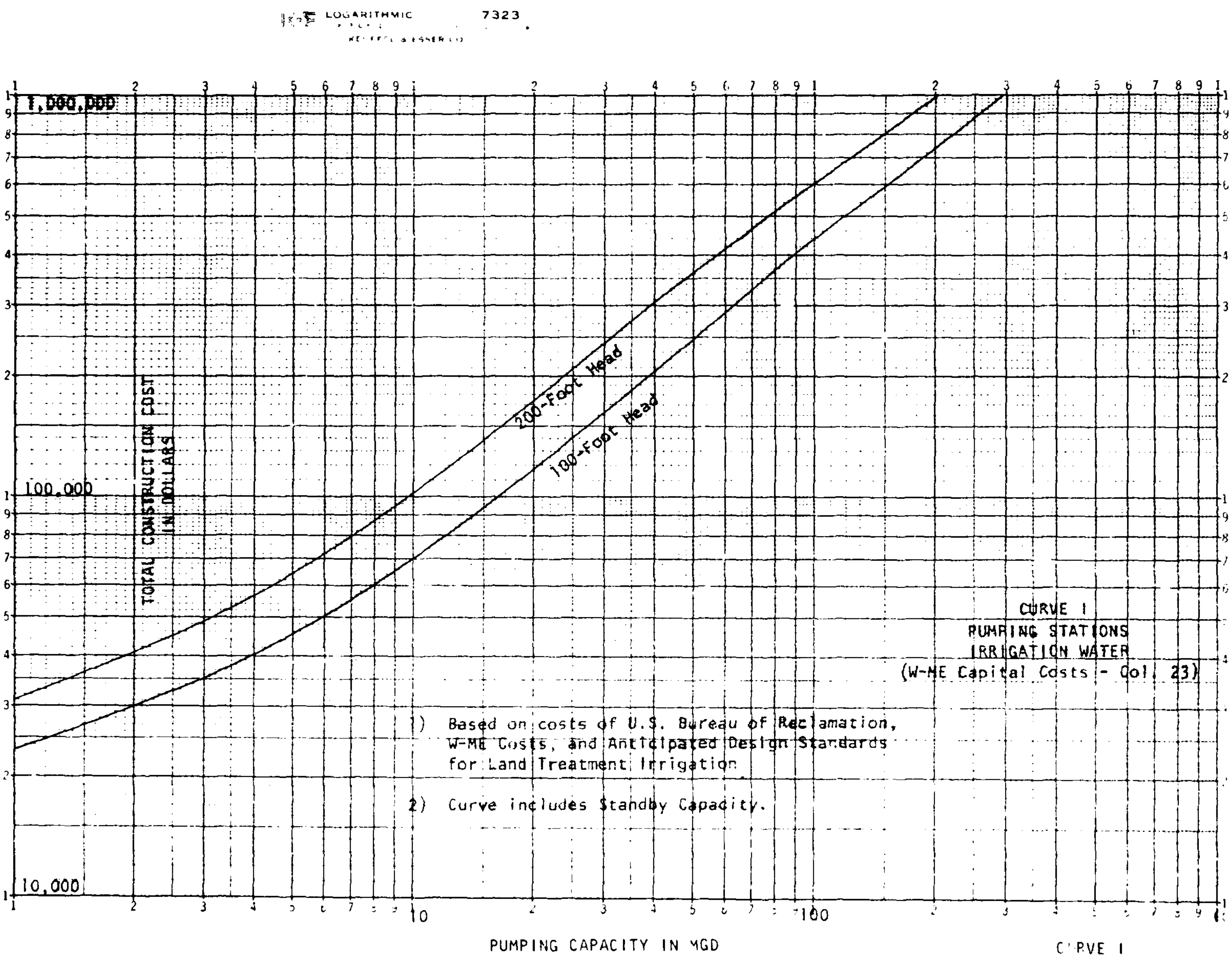
K+E LOGARITHMIC 46 7323
KEUFFEL & ESSER CO.
CONSTRUCTION COST IN DOLLARS
10,000,000
9,000,000
8,000,000
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
800'
300'
Circled points taken from
Bauer Technical Appendix
C-SELM Report
March, 1972
CURVE E
Capital Costs for
TUNNEL PUMPING STATIONS
UNTREATED SEWAGE
(INCLUDES STANDBY CAPACITY)
(W-ME Capital Costs - Col. 15)
Note: Add shaft costs from surface.
Cost includes underground excavation, intakes and sump chamber.
Standby capacity included.
Use peak flow rate for costing.
For treated effluent, reduce costs 75%.
1 2 3 4 5 6 7 8 9 10 20 30 40 50 60 70 80 90 100 200 300 400 500 600 700 800 900 1000
CURVE E
PLANT SIZE IN MGD

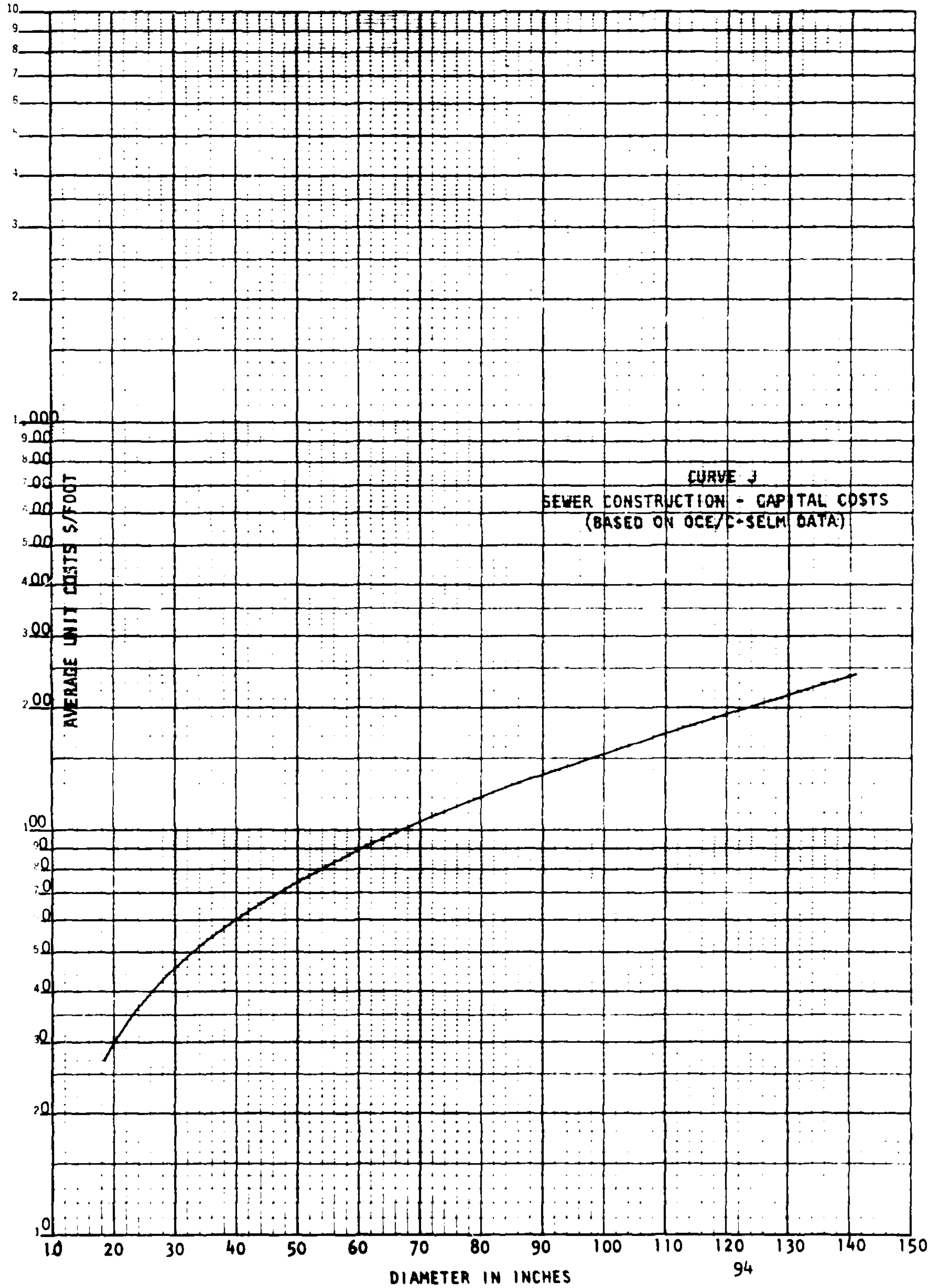

CURVE F
STORAGE RESERVOIRS AND DETENTION PONDS
CAPITAL COSTS
(W-ME CAPITAL COSTS - COLUMN 17)
STORAGE IN MG
1,000,000
100,000
10,000
1,000
100
10
1,000
2,000
3,000
4,000
5,000
6,000
7,000
COST PER MG IN DOLLARS


CURVE G
AERATED LAGOONS
CAPITAL COSTS
(W-HE CAPITAL COSTS - COL. 10)
CAPITAL COSTS ($)
100,000,000
10,000,000
1,000,000
0.2
0.3
1.0
2.0
10
20
30
40
50
100
200
1000
AERATED LAGOON - TREATMENT CAPACITY (MGD)

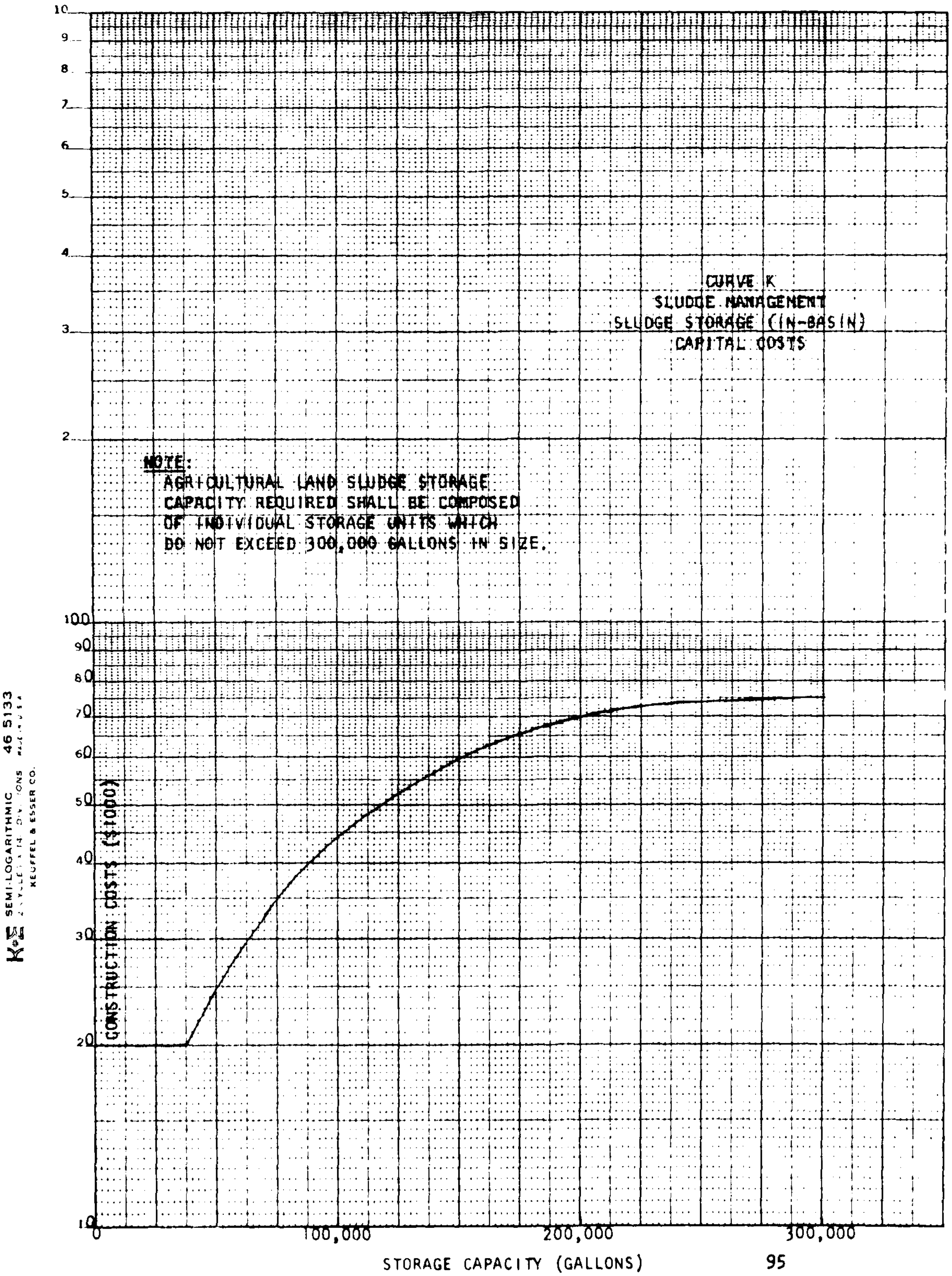
CURVE G

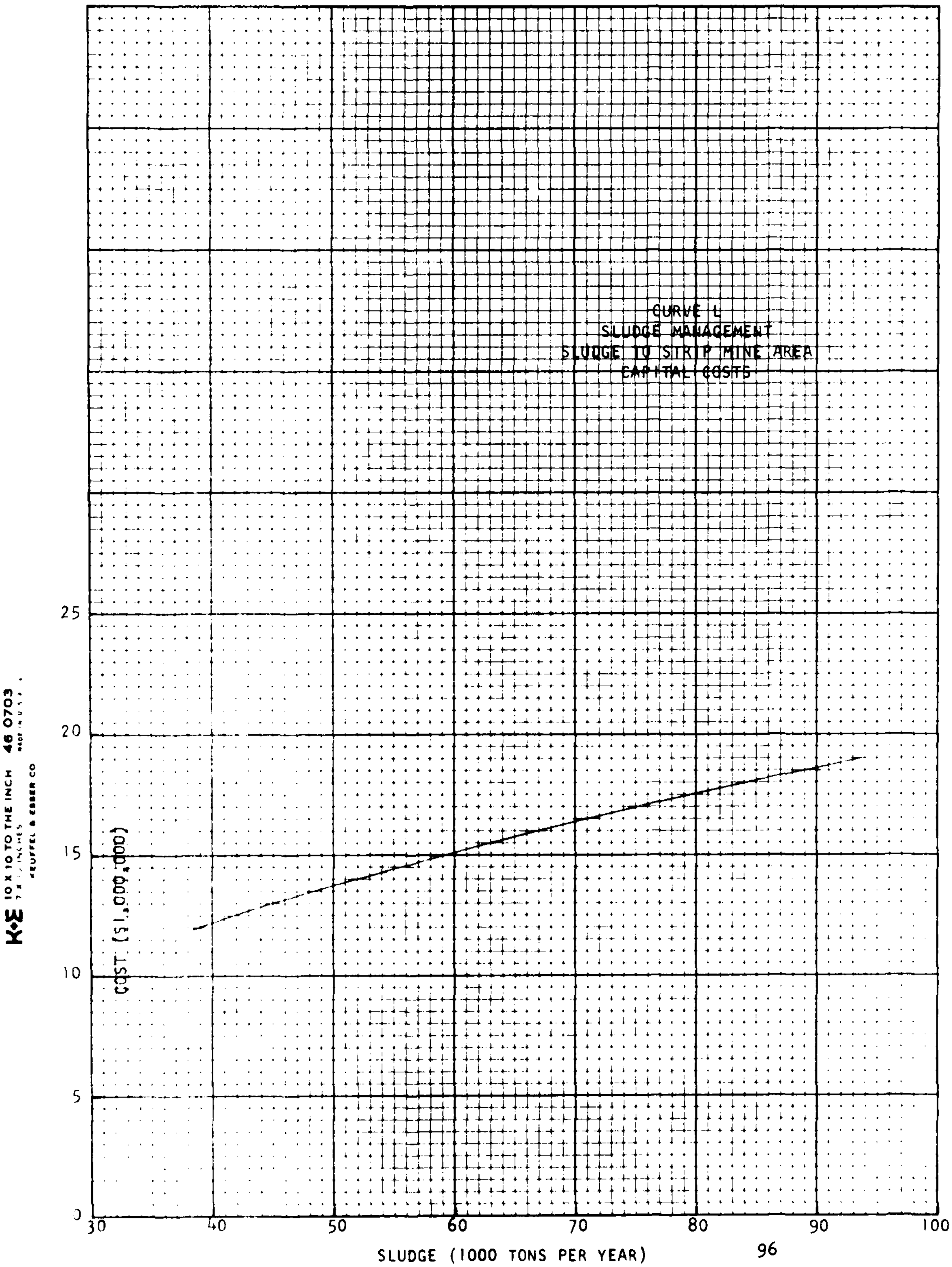

CURVE H
CHLORINATION - CAPITAL COSTS
WEE COST CURVE 5/32 (15 MIN)
(WHE CAPITAL COSTS - COLUMN 19)
15 MIN.
$1,000/MGD
PLANT SIZE (MGD)
CURVE H


LOGARITHMIC 7323
KEUFFEL & ESSER CO.
1,000,000
100,000
10,000
TOTAL CONSTRUCTION COST IN DOLLARS
200-Foot Head
100-Foot Head
CURVE I
PUMPING STATIONS
IRRIGATION WATER
(W-ME Capital Costs - Col. 23)
1) Based on costs of U.S. Bureau of Reclamation, W-ME Costs, and Anticipated Design Standards for Land Treatment Irrigation.
2) Curve includes Standby Capacity.
10
100
PUMPING CAPACITY IN MGD
CURVE I


CURVE J
SEWER CONSTRUCTION - CAPITAL COSTS
(BASED ON OCE/C-SELM DATA)
AVERAGE UNIT COSTS $/FOOT
DIAMETER IN INCHES
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
1,000 900 800 700 600 500 400 300 200 100 90 80 70 60 50 40 30 20 10

CURVE J


CURVE K
SLUDGE MANAGEMENT
SLUDGE STORAGE (IN-BASIN)
CAPITAL COSTS
NOTE:
AGRICULTURAL LAND SLUDGE STORAGE
CAPACITY REQUIRED SHALL BE COMPOSED
OF INDIVIDUAL STORAGE UNITS WHICH
DO NOT EXCEED 300,000 GALLONS IN SIZE.
CONSTRUCTION COSTS ($1000)
10
20
30
40
50
60
70
80
90
100
0
100,000
200,000
300,000
STORAGE CAPACITY (GALLONS)
SEMI-LOGARITHMIC 46 5133
KEUFFEL & ESSER CO.



CURVE L
SLUDGE MANAGEMENT
SLUDGE TO STRIP MINE AREA
CAPITAL COSTS
COST ($1,000,000)
0
5
10
15
20
25
30
40
50
60
70
80
90
100
SLUDGE (1000 TONS PER YEAR)
K+E 10 X 10 TO THE INCH 46 0703
KEUFFEL & ESSER CO.

CURVE L

TABLE VI-3

DETAILED CAPITAL COSTS FOR PLAN 7

FOR FACILITIES RECEIVING: Municipal-Industrial/Combined S.R.O./Municipal S.T.P. Treated S.R.O. X
Separately Treated S.R.O. Only . . . . ____

PERCENT OF GRAND TOTAL FOR CAPITAL COSTS: Municipal and Industrial. . . . . . . ____%
Combined and Separately-Sewered S.R.O. ____%

All costs in $1,000

	BASIC DESIGN DATA					TREATMENT FACILITIES						TRANSMISSION FACILITIES			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
PLANT NAME	Detention Storage (MG)	Plant Capacity (MGD)	Raw Sludge (TPD)	Winter Storage (MG)	Acres	Detention Storage	Sewers	Pump Station	Plant	Sludge	Total Columns 7-11	Pump Plant	Force Main Drop Shaft Tunnel	Secondary Pump Plant	Force Main
IN BASIN															
ROCKY RIVER															
Upper E. Branch	--	1.11	0.72	172	250									135	195
Hinckley	55	1.72	1.11	405	1,550									170	330
Mallet Creek	--	0.60	0.39	93	135									110	44
Sub-Totals	55	3.43	2.22	670	1,935									415	569
CHAGRIN RIVER															
Newbury Twp.	--	1.54	0.97	238	345									160	105
Fowler's Mill	--	2.00	1.28	310	450									180	130
Silver Cr. (Fairmount Road)	70	3.40	2.19	702	1,032									250	480
Aurora Central	45	2.98	.92	575	845									500	990
Chagrin E. Branch	--	1.95	.26	302	440									180	88
Sub-Totals	115	11.87	1.62	2,127	3,112									1,270	1,793
CUYAHOGA RIVER															
E. Claridon	--	0.48	0.31	74	250									100	220
Butternut Creek	--	1.17	0.75	181	265									140	240
Burton	95	3.61	2.33	798	1,175									125	104
Auburn Twp.	--	0.84	0.54	129	190									120	52
Troy Twp.	--	0.47	0.30	73	106									100	110
Mantua	13	0.86	0.56	227	239									120	234
Shalersboro	--	2.00	1.29	310	450									180	110
Randolph	--	0.75	0.48	116	170									120	52
Sub-Totals	108	10.18	6.56	1,908	2,845									1,005	1,122
In-Basin Totals	278	25.48	16.40	4,705	7,892									2,690	3,484

TABLE VI-3 (Continued)

DETAILED CAPITAL COSTS FOR PLAN 7

FOR FACILITIES RECEIVING: Municipal-Industrial/Combined S.R.O./Municipal S.T.P. Treated S.R.O. X
Separately Treated S.R.O. Only . . . . ____

All costs in $1,000

	STORAGE RESERVOIR			LAND TREATMENT SITE			IRRIGATION SYSTEM			DRAINAGE SYSTEM			MISC.	
	17	18	19	20	21	22	23	24	25	26	27	28	29	30
PLANT NAME	Reservoir	Aeration	Chlorination	Purchase and Relocation		Site Preparation	Pump Station	Force Main	Equipment and Distribution Piping	Tile	Conduits and Canals	Sludge Management	Monitoring, Admin. & Labs., Elec.	Total Columns 7-29
IN BASIN														
ROCKY RIVER														
Upper E. Branch	676	146	21	103		11	60	13	77	46	4	45	10	
Hinckley	1,310	345	72	644		70	105	90	483	284	27	60	50	
Mallet Creek	407	79	10	56		6	30	26	42	26	2	25	6	
Sub-Totals	2,393	570	103	803		87	195	129	602	366	33	130	66	
CHAGRIN RIVER														
Newbury Twp.	860	202	25	143		15	50	15	107	62	6	55	12	
Fowler's Mill	1,080	263	32	186		20	95	65	139	82	8	65	19	
Silver Cr. (Fairmount Road)	1,970	600	96	427		47	120	45	321	188	18	To Strip Mine Land	35	
Aurora Central	1,690	490	82	351		38	110	90	264	155	15	To Strip Mine Land	32	
Chagrin E. Branch	1,040	256	48	187		20	80	22	137	81	8	63	16	
Sub-Totals	6,640	1,811	283	1,294		140	455	237	968	568	55	183	114	
CUYAHOGA RIVER														
E. Claridon	336	63	18	103		11	135	30	78	46	4	22	15	
Butternut Creek	697	154	33	110		12	48	13	83	48	5	45	10	
Burton	2,168	680	105	488		53	130	45	365	214	20	85	38	
Auburn Twp.	1,027	250	40	79		8	68	22	59	35	3	35	9	
Troy Twp.	336	63	15	44		5	45	13	33	20	2	22	6	
Mantua	838	193	30	99		11	60	30	75	44	4	35	11	
Shalersboro	1,080	255	49	186		20	80	22	140	83	8	65	16	
Randolph	490	98	22	71		7	52	15	53	31	3	28	8	
Sub-Totals	6,972	1,756	312	1,180		127	618	190	886	521	49	337	113	
In-Basin Totals	16,005	4,137	698	3,277		354	1,268	556	2,456	1,455	137	650	293	
							Sludge via Pipeline to Strip-Mined Areas (For 6 Plants Including Silver Creek & Aurora Central)					20,000		
							Sludge Management Total (9 Other Plants to Incineration Costed by M&E)					20,650		

TABLE VI-3 (Continued

DETAILED CAPITAL COSTS FOR PLAN 7

FOR FACILITIES RECEIVING: Municipal-Industrial/Combined S.R.O./Municipal S.T.P. Treated S.R.O. ____
Separately Treated S.R.O. Only X

PERCENT OF GRAND TOTAL FOR CAPITAL COSTS: Municipal and Industrial. . . . . . . ____%
Combined and Separately-Sewered S.R.O. ____%

All costs in $1,000

	BASIC DESIGN DATA					TREATMENT FACILITIES						TRANSMISSION FACILITIES			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
PLANT NAME	Detention Storage (MG)	Plant Capacity (MGD)	Raw Sludge (TPD)	Winter Storage (MG)	Acres	Detention Storage	Sewers	Pump Station	Plant	Sludge	Total Columns 7-11	Pump Plant	Force Main Drop Shaft Tunnel	Secondary Pump Plant	Force Main
IN BASIN															
CHAGRIN RIVER															
CHN-12 (SWTP #15)	19.8			48	73									83	91
CHN-13 (SWTP #15)	34.4			86	107									100	150
CHN-25 (SWTP #20)	25.4			64	104									91	52
CHN-31 (SWTP #31)	16.6			42	64									80	104
CHN-35 (SWTP #48)	18.9			47	73									83	60
CHN-36 (SWTP #48)	26.4			67	103									91	60
Sub-Total	141.5			354	524									528	517
ROCKY RIVER															
R-29 (SWTP #7)	27.0			68	104									92	165
CUYAHOGA RIVER															
CU-53 (SWTP #27)	124.0			310	1,100									170	900
CU-67 (SWTP #32)	55.0			137	211									115	418
CU-73 (SWTP #33)	11.2			28	54									71	90
CU-74 (SWTP #33)	19.7			49	75									84	75
CU-75 (SWTP #34)	28.0			70	107									90	70
CU-76 (SWTP #34)	13.6			34	52									75	50
Sub-Total	251.5			628	1,599									605	1,603
In-Basin Totals	420.0			1,050	2,227									1,225	2,285

TABLE VI-3 (Continued)

DETAILED CAPITAL COSTS FOR PLAN 7

FOR FACILITIES RECEIVING: Municipal-Industrial/Combined S.R.O./Municipal S.T.P. Treated S.R.O. ___
Separately Treated S.R.O. Only X

All costs in $1,000

	STORAGE RESERVOIR			LAND TREATMENT SITE			IRRIGATION SYSTEM			DRAINAGE SYSTEM			MISC.	
	17	18	19	20	21	22	23	24	25	26	27	28	29	30
PLANT NAME	Reservoir	Aeration	Chlorination	Purchase and Relocation		Site Preparation	Pump Station	Force Main	Equipment and Distribution Piping	Tile	Conduits and Canals	Sludge Management	Monitoring, Admin. & Labs., Elec.	Total Columns 7-29
IN BASIN														
CHAGRIN RIVER														
CHN-12 (SWTP #15)	244		13	18		2	34	5	14	8	1		3	
CHN-13 (SWTP #15)	387		18	26		3	42	8	21	11	1		4	
CHN-25 (SWTP #20)	310		16	25		3	38	6	20	11	1		4	
CHN-31 (SWTP #31)	217		12	15		2	33	3	12	7	1		3	
CHN-35 (SWTP #48)	239		11	18		2	39	9	14	8	1		4	
CHN-36 (SWTP #48)	325		15	25		1	44	10	20	11	1		4	
Sub-Total	1,722		85	129		13	230	41	101	56	6		22	
ROCKY RIVER														
R-29 (SWTP #7)	324		17	25		3	38	7	20	11	1		4	
CUYAHOGA RIVER														
CU-53 (SWTP #27)	1,110		57	273		32	71	38	213	118	9		22	
CU-67 (SWTP #32)	577		27	53		6	49	12	41	22	2		6	
CU-73 (SWTP #33)	153		7	13		1	32	7	10	6	1		3	
CU-74 (SWTP #33)	247		11	19		2	40	9	14	8	1		4	
CU-75 (SWTP #34)	333		8	13		1	35	8	10	5	1		3	
CU-76 (SWTP #34)	182		12	20		2	41	9	15	9	1		4	
Sub-Total	2,602		122	391		44	268	83	303	168	15		42	
In-Basin Totals	4,648		224	545		60	536	131	424	235	22		68	

TABLE VI-4

DETAILED OPERATION AND MAINTENANCE COSTS FOR PLAN 7

FOR FACILITIES RECEIVING: Municipal-Industrial/Combined S.R.O./Municipal S.T.P. Treated S.R.O. X
Separately Treated S.R.O. Only. X

PERCENT OF GRAND TOTAL FOR O. & M. COSTS: Municipal and Industrial . . . . ____%
Combined and Separately-Sewered S.R.O. ____%

All costs in $1,000

	BASIC DESIGN DATA					TREATMENT FACILITIES						TRANSMISSION FACILITIES					
1	2	3	4	5	6	7	8	9	10	11	12	13		14	15		16
PLANT NAME	Detention Storage (MG)	Plant Capacity (MGD)	Raw Sludge (TPD)	Winter Storage (MG)	Acres	Detention Storage	Sewers	Pump Station	Plant	Sludge	Total Columns 7-11	Pump Plant		Force Main Drop Shaft Tunnel	Secondary Pump Plant		Force Main
												13A	13B	14	15A	15B	16
												Power	Maint & Labor	Maintenance & Labor	Power	Maint & Labor	Maintenance & Labor
IN BASIN																	
Combined		25.48	16.40	4,705	5,462										141	134	17
Separate Stormwater		7.16			919										40	61	11

TABLE VI-4 (Continued)

DETAILED OPERATION AND MAINTENANCE COSTS FOR PLAN 7

FOR FACILITIES RECEIVING: Municipal-Industrial/Combined S.R.O./Municipal S.T.P. Treated S.R.O. X
Separately Treated S.R.O. Only X

All Costs In $1,000

	STORAGE RESERVOIR					LAND TREATMENT SITE			IRRIGATION SYSTEM				DRAINAGE SYSTEM				MISC.	
	17	18		19		20	21	22	23		24	25	26	27	28		29	30
PLANT NAME	Reservoir	Aeration		Chlorination		Purchase and Relocation		Site Preparation	Pump Station		Force Main	Equipment & Distribution Piping	Tile	Conduits & Canals	Sludge Management		Monitoring, Admin. & Labs., Elec.	Total Columns 7-29
	17	18A	18B	19A	19B				23A	23B					28A	28B		
	Maintenance & Labor	Power	Maint. & Labor	Power	Maint. & Labor	No O & M		No O & M	Power	Maint. & Labor	Maintenance & Labor	Maint. & Labor	Maintenance & Labor	Maint. & Labor	Power	Maint. & Labor	Maint. & Labor	
IN BASIN																		
Combined	80	94	94		46				98	63	3	22	22	11	19	10	29	
Separate Stormwater	23				13				33	27	1	4	4	2			7	

TABLE VI-5

DETAILED CAPITAL COSTS FOR PLAN 12

FOR FACILITIES RECEIVING: Municipal-Industrial/Combined S.R.O./Municipal S.T.P. Treated S.R.O. X
Separately Treated S.R.O. Only . . . . ____

PERCENT OF GRAND TOTAL FOR CAPITAL COSTS: Municipal and Industrial. . . . . . . ____%
Combined and Separately-Sewered S.R.O. ____%

All costs in $1,000

	BASIC DESIGN DATA					TREATMENT FACILITIES						TRANSMISSION FACILITIES			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
PLANT NAME	Detention Storage (MG)	Plant Capacity (MGD)	Raw Sludge (TPD)	Winter Storage (MG)	Acres	Detention Storage	Sewers	Pump Station	Plant	Sludge	Total Columns 7-11	Pump Plant	Force Main Drop Shaft Tunnel	Secondary Pump Plant	Force Main
								10A Preliminary Treatment	10B Aerated Lagoons	10C Disinfection					
IN BASIN															
ROCKY RIVER															
Upper E. Branch	61	1.11	0.72	183	402			34	560	19				90	195
Hinkley	55	1.72	1.11	226	472			34	660	28				110	330
Medina County	--	5.00	3.22	425	900			70	1,050	65				165	180
New Medina	--	9.49	6.12	807	1,275			101	1,700	110				230	450
Mallet Creek	--	0.60	0.39	51	90			27	250	12				76	44
Liverpool	--	5.00	3.22	425	750			70	1,050	65				165	240
Sub-Totals	116	22.92	14.78	2,117	3,889			336	5,270	299				836	1,439
CHAGRIN RIVER															
Haven Road (Newbury)	--	3.54	2.25	550	785			54	800	50				140	210
Silver Cr. (Fairmount Road)	57	3.40	2.19	678	988			54	940	48				140	480
Aurora Central	33	2.98	1.92	561	842			51	840	45				130	990
McFarland Creek	51	4.29	2.76	803	1,169			63	1,050	60				150	1,020
Chagrin Falls	96	3.58	2.31	788	1,166			56	1,050	50				140	420
Chagrin E. Branch	--	1.95	1.26	302	440			40	540	31				110	88
Sub-Totals	237	19.74	12.69	3,682	5,390			318	5,220	284				810	3,208
								Included in HOE Costs							

TABLE VI-5 (Continued)

DETAILED CAPITAL COSTS FOR PLAN 12

FOR FACILITIES RECEIVING: Municipal-Industrial/Combined S.R.O./Municipal S.T.P. Treated S.R.O. X
Separately Treated S.R.O. Only . . . .

All costs in $1,000

	STORAGE RESERVOIR			LAND TREATMENT SITE			IRRIGATION SYSTEM			DRAINAGE SYSTEM			MISC.	
	17	18	19	20	21	22	23	24	25	26	27	28	29	30
PLANT NAME	Reservoir	Aeration	Chlorination	Purchase and Relocation		Site Preparation	Pump Station	Force Main	Equipment and Distribution Piping	Tile	Conduits and Canals	Sludge Management	Monitoring, Admin. & Labs., Elec.	Total Columns 7-29
IN BASIN														
ROCKY RIVER														
Upper E. Branch	740	128	42	120		26	41	15	86	171	10	8	16	
Hinckley	880	158	49	142		31	47	60	100	201	12	13	21	
Medina County	1,440	298	80	270		59	70	40	194	382	23	39	35	
New Medina	2,340	565	130	382		83	110	60	274	541	32	72	51	
Mallet Creek	260	36	15	27		6	25	22	19	38	2	5	5	
Liverpool	1,440	298	80	225		49	70	40	161	319	19	39	31	
Sub-Totals	7,100	1,483	396	1,166		254	363	237	834	1,652	98	176	159	
CHAGRIN RIVER														
Haven Road (Newbury)	1,750	385	85	235		51	87	81	350	196	20	27	37	
Silver Cr. (Fairmount Road)	2,030	474	90	296		64	76	45	470	247	25	26	43	
Aurora Central				252		54			400	210	21	23		
McFarland Creek	4,830	1,510	245	350		76	230	180	555	292	29	33	140	
Chagrin Falls				350		76			554	291	29	27		
Chagrin E. Branch	1,100	211	48	132		29	56	22	209	110	11	15	20	
Sub-Totals	9,710	2,580	468	1,615		350	449	328	2,538	1,346	135	151	240	

TABLE VI-5 (Continued)

DETAILED CAPITAL COSTS FOR PLAN 12

FOR FACILITIES RECEIVING: Municipal-Industrial/Combined S.R.O./Municipal S.T.P. Treated S.R.O. X
Separately Treated S.R.O. Only . . . . ____

PERCENT OF GRAND TOTAL FOR CAPITAL COSTS: Municipal and Industrial. . . . . . . ____%
Combined and Separately-Sewered S.R.O. ____%

All costs in $1,000

	BASIC DESIGN DATA					TREATMENT FACILITIES						TRANSMISSION FACILITIES			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
PLANT NAME	Detention Storage (MG)	Plant Capacity (MGD)	Raw Sludge (TPD)	Winter Storage (MG)	Acres	Detention Storage	Sewers	Pump Station	Plant	Sludge	Total Columns 7-11	Pump Plant	Force Main Drop Shaft Tunnel	Secondary Pump Plant	Force Main
								10A Preliminary Treatment	10B Aerated Lagoons	10C Disinfection					
IN BASIN															
CUYAHOGA RIVER															
Chardon Windsor	--	0.20	0.13	36	30			27	125	5				60	63
East Claridon	--	0.48	0.31	87	110			27	215	10				72	220
Butternut Creek	--	1.17	0.75	181	260			29	380	21				90	240
Middlefield	54	2.70	1.74	561	817			48	820	41				125	300
Burton	36	0.91	0.59	236	337			27	450	16				88	104
Auburn Twp.	37	0.84	0.54	229	324			27	440	15				84	52
Troy Twp.	--	0.47	0.30	73	106			27	215	10				72	110
Mantua	12	0.86	0.56	164	235			27	355	15				84	234
Shalersboro	--	2.00	1.29	310	450			40	540	32				110	110
Ravenna	--	12.34	7.95	1,910	2,770			130	2,050	130				270	1,720
Randolph	--	0.75	0.48	116	170			27	285	14				82	52
New Kent	177	28.95	18.30	4,960	7,191			190	4,600	240				480	3,088
Tinkers Creek	235	7.20	4.65	1,743	2,500			90	1,900	86				200	1,850
Sub-Totals	551	58.87	37.59	12,706	15,300			716	12,375	635				1,817	8,143
AKRON															
Area "A"		(88.8)		7,530	13,250			320	10,400	440				1,100	5,715
Area "B"		(65.0)		5,500	9,750			230	7,600	400				860	6,750
Sub-Totals		146.9	80.94	13,030	23,000			550	18,000	840				1,960	12,465
In-Basin Totals		248.43	146.00	31,535	47,579			1,920	40,865	2,058				5,423	25,255
								Included in H&E Costs							

TABLE VI-5 (Continued)

DETAILED CAPITAL COSTS FOR PLAN 12

FOR FACILITIES RECEIVING: Municipal-Industrial/Combined S.R.O./Municipal S.T.P. Treated S.R.O. X
Separately Treated S.R.O. Only . . . . ____

All costs in $1,000

	STORAGE RESERVOIR			LAND TREATMENT SITE			IRRIGATION SYSTEM			DRAINAGE SYSTEM			MISC.	
	17	18	19	20	21	22	23	24	25	26	27	28	29	30
PLANT NAME	Reservoir	Aeration	Chlorination	Purchase and Relocation		Site Preparation	Pump Station	Force Main	Equipment and Distribution Piping	Tile	Conduits and Canals	Sludge Management	Monitoring, Admin. & Labs., Elec.	Total Columns 7-29
IN BASIN														
CUYAHOGA RIVER														
Chardon Windsor	195	25	8	9		2	20	9	6	13	1	1	2	
East Claridon	404	61	15	33		7	26	13	52	28	3	4	6	
Butternut Creek	734	127	32	78		17	36	15	123	65	7	9	12	
Middlefield	1,780	393	79	245		53	78	30	388	204	20	21	36	
Burton	910	165	40	101		22	40	22	160	84	8	7	16	
Auburn Twp.	880	160	40	97		21	40	22	154	81	8	6	15	
Troy Twp.	350	51	15	32		7	25	13	50	26	3	4	6	
Mantua	677	115	30	70		15	34	30	111	59	6	7	12	
Shalersboro	1,120	217	49	135		29	47	22	214	112	11	15	20	
Ravenna	5,290	1,340	178	830		180	152	120	1,315	693	69	96	118	
Randolph	510	81	22	51		11	30	15	81	42	4	6	9	
New Kent	8,680	3,470	374	2,150		467	408	398	3,420	1,798	180	221	305	
Tinkers Creek	4,360	1,220	180	750		163	160	90	1,190	625	62	56	106	
Sub-Totals	25,890	7,425	1,062	4,581		994	1,096	699	7,264	3,830	382	453	663	
AKRON														
Area "A"	11,300		610	7,950		860	480	4,560	2,840	5,620	331	652	691	
Area "B"	9,350		493	5,850		635	380	4,110	2,100	4,150	244	478	549	
Sub-Totals	20,650		1,103	13,800		1,495	860	8,670	4,940	9,770	575	1,130	1,240	
In-Basin Totals	63,350	11,488	3,029	21,162		3,093	2,768	9,934	15,576	16,598	1,190	1,910	2,302	

TABLE VI-5 (Continued)

DETAILED CAPITAL COSTS FOR PLAN 12

FOR FACILITIES RECEIVING: Municipal-Industrial/Combined S.R.O./Municipal S.T.P. Treated S.R.O. X
Separately Treated S.R.O. Only . . . . ____

PERCENT OF GRAND TOTAL FOR CAPITAL COSTS: Municipal and Industrial. . . . . . . ____%
Combined and Separately-Sewered S.R.O. ____%

All costs in $1,000

	BASIC DESIGN DATA					TREATMENT FACILITIES						TRANSMISSION FACILITIES			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
PLANT NAME	Detention Storage (MG)	Plant Capacity (MGD)	New Sludge (TPD)	Winter Storage (MG)	Acres	Detention Storage	Sewers	Pump Station	Plant	Sludge	Total Columns 7-11	Pump Plant	Force Main Drop Shaft Tunnel	Secondary Pump Plant	Force Main
								10A	10B	10C					
								Preliminary Treatment	Aerated Lagoons	Disinfection					
OUT-OF-BASIN (Cleveland	Shoreline	Tunnel)													
North Olmsted	698	37.00	23.8					260				1,300	1,670		
Rocky River	298	22.05	14.2					180				860	15,280		
Lakewood	166	21.00	13.5					180				800	10,860		
Westerly	1,070	41.70	29.2					280					4,545		
Southerly	1,582	178.20	119.0					620					32,800		
Easterly	1,054	172.00	111.0					600					30,735		
Euclid	306	37.34	24.1					240					8,899		
Willoughby-East Lake	463	22.27	14.3					180				910	2,500		
Sub-Total (Shoreline)	5,637	531.56	349.1	98,700	133,500			2,540	83,000	1,700		3,870	340,539	26,560	–
Sub-Total (In-Basin)		248.43	146.0	31,535	47,579			1,920	40,865	2,058		–	–	7,931	25,255
GRAND TOTAL		779.99	4[illegible]5.1	130,235	181,079			4,460	123,865	3,758		3,870	340,539	34,491	25,255
								Included in H&E Costs							

TABLE VI-5 (Continued)
DETAILED CAPITAL COSTS FOR PLAN 12

FOR FACILITIES RECEIVING: Municipal-Industrial/Combined S.R.O./Municipal S.T.P. Treated S.R.O. X
Separately Treated S.R.O. Only . . . . ____

All costs in $1,000

	STORAGE RESERVOIR			LAND TREATMENT SITE			IRRIGATION SYSTEM			DRAINAGE SYSTEM			MISC.	
	17	18	19	20	21	22	23	24	25	26	27	28	29	30
PLANT NAME	Reservoir	Aeration	Chlorination	Purchase and Relocation		Site Preparation	Pump Station	Force Main	Equipment and Distribution Piping	Tile	Conduits and Canals	Sludge Management	Monitoring, Admin. & Labs., Elec.	Total Columns 7-29
OUT-OF-BASIN (Cleveland Shoreline Tunnel)														
North Olmsted														
Rocky River														
Lakewood														
Westerly														
Southerly														
Easterly														
Euclid														
Willoughby-East Lake														
Sub-Total (Shoreline)	54,285	-	2,224	77,000		8,340	5,800	54,000	46,250	57,200	3,210	4,090	8,320	
Sub-Total (In-Basin)	63,350	11,488	3,029	21,162		3,093	2,768	9,934	15,576	16,598	1,190	1,910	2,302	
GRAND TOTAL	117,635	11,488	5,253	98,162		11,433	8,568	63,934	61,826	73,798	4,400	6,000	10,622	

TABLE VI-5 (Continued)

DETAILED CAPITAL COSTS FOR PLAN 12

FOR FACILITIES RECEIVING: Municipal-Industrial/Combined S.R.O./Municipal S.T.P. Treated S.R.O. ____
Separately Treated S.R.O. Only X

PERCENT OF GRAND TOTAL FOR CAPITAL COSTS: Municipal and Industrial. . . . . . . ____%
Combined and Separately-Sewered S.R.O. ____%

All costs in $1,000

	BASIC DESIGN DATA					TREATMENT FACILITIES						TRANSMISSION FACILITIES			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
PLANT NAME	Detention Storage (MG)	Plant Capacity (MGD)	Raw Sludge (TPD)	Winter Storage (MG)	Acres	Detention Storage	Sewers	Pump Station	Plant	Sludge	Total Columns 7-11	Pump Plant	Force Main Drop Shaft Tunnel	Secondary Pump Plant	Force Main
ROCKY RIVER															
SWTP #13 (LE-12)	44			146	154									300	380
#11 (R-11)	29			80	85									235	600
#12 (R-12)	59			203	503									365	765
#10 (R-19)	18			59	62									180	220
# 9 (R-20)	27			86	226									225	240
# 8 (R-23,25)	51			165	173									330	645
# 7 (R-26)	4			12	12									100	75
# 6 (R-27)	15			51	53									165	264
# 2 (R-28)	64			210	220									380	152
# 1 (R-29)	12			40	104									150	220
# 3 (R-30,33)	9			34	34									130	105
# 5 (R-31,32)	24			84	87									210	176
# 4 (R-34,35)	33			110	117									255	90
Sub-Total	389			1,280	1,830									3,025	3,932
CHAGRIN RIVER															
SWTP #37 (CHN-7)	4			26	15									95	45
#36 (CHN-8)	5			31	18									105	135
#39 (CHN-9)	11			67	39									140	40
#38 (CHN-10)	32			195	112									250	150
#34 (CHN-12)	9			51	29									130	120
#35 (CHN-13)	16			91	53									170	220
#30 (CHN-18)	3			17	10									90	90
#31 (CHN-19)	3			20	12									90	105
#29 (CHN-25)	12			68	39									150	88
#28 (CHN-31)	7			44	26									115	140
#33 (CHN-35,36)	21			120	71									195	210
#27 (CHN-29)	3			11	26									90	30
Sub-Total	126			741	450									1,620	1,373

TABLE VI-5 (Continued)

DETAILED CAPITAL COSTS FOR PLAN 12

FOR FACILITIES RECEIVING: Municipal-Industrial/Combined S.R.O./Municipal S.T.P. Treated S.R.O. ____
Separately Treated S.R.O. Only X

All costs in $1,000

	STORAGE RESERVOIR			LAND TREATMENT SITE			IRRIGATION SYSTEM			DRAINAGE SYSTEM			MISC.	
	17	18	19	20	21	22	23	24	25	26	27	28	29	30
PLANT NAME	Reservoir	Aeration	Chlorination	Purchase and Relocation		Site Preparation	Pump Station	Force Main	Equipment and Distribution Piping	Tile	Conduits and Canals	Sludge Management	Monitoring, Admin. & Labs., Elec.	Total Columns 7-29
ROCKY RIVER														
SWTP #13 (LE-12)	620		34	92		10	37	40	33	65	4		9	
#11 (R-11)	380		22	51		5	29	30	18	36	2		6	
#12 (R-12)	810		46	302		33	44	40	113	214	12		21	
#10 (R-19)	295		16	38		4	26	30	13	26	1		5	
# 9 (R-20)	395		22	136		15	29	30	48	96	6		10	
# 8 (R-23,25)	725		41	108		11	41	40	37	74	4		8	
# 7 (R-26)				7		1			3	5	1		1	
# 6 (R-27)	260		15	30		3	25	30	11	22	1		4	
# 2 (R-28)	820		47	132		14	45	40	47	93	5		12	
# 1 (R-29)	212		12	62		7	23	18	22	44	3		6	
# 3 (R-30,33)	185		10	20		2	20	18	7	14	1		3	
# 5 (R-31,32)	395		22	52		6	29	30	18	37	2		6	
# 4 (R-34,35)	490		28	70		7	33	30	25	50	3		7	
Sub-Total	5,029		315	1,100		118	381	376	395	776	45		98	
CHAGRIN RIVER														
SWTP #37 (CHN-7)	148		7	9		1	15	18	7	4	1		2	
#36 (CHN-8)	172		8	11		1	15	18	9	5	1		2	
#39 (CHN-9)	320		14	23		3	24	18	19	10	1		4	
#38 (CHN-10)	780		33	67		7	36	30	53	28	3		8	
#34 (CHN-12)	260		11	17		2	22	18	14	7	1		3	
#35 (CHN-13)	420		18	32		3	27	30	25	13	1		5	
#30 (CHN-18)	105		5	6		1	10	18	5	3	--		2	
#31 (CHN-19)	120		5	7		1	10	18	6	3	--		2	
#29 (CHN-25)	330		14	23		3	24	18	19	10	1		4	
#28 (CHN-31)	230		10	16		2	20	18	12	7	1		3	
#33 (CHN-35,36)	530		24	43		5	30	30	34	18	2		6	
#27 (CHN-29)	72		3	16		2	8	18	12	7	1		2	
Sub-Total	2,875		152	270		31	241	234	215	115	13		43	

TABLE VI-5 (Continued)

DETAILED CAPITAL COSTS FOR PLAN 12

FOR FACILITIES RECEIVING: Municipal-Industrial/Combined S.R.O./Municipal S.T.P. Treated S.R.O. ____
Separately Treated S.R.O. Only X

PERCENT OF GRAND TOTAL FOR CAPITAL COSTS: Municipal and Industrial. . . . . . . ____%
Combined and Separately-Sewered S.R.O. ____%

All costs in $1,000

	BASIC DESIGN DATA					TREATMENT FACILITIES						TRANSMISSION FACILITIES			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
PLANT NAME	Detention Storage (MG)	Plant Capacity (MGD)	Raw Sludge (TPD)	Winter Storage (MG)	Acres	Detention Storage	Sewers	Pump Station	Plant	Sludge	Total Columns 7-11	Pump Plant	Force Main Drop Shaft Tunnel	Secondary Pump Plant	Force Main
CUYAHOGA RIVER															
SWTP #26 (CU-34)	14			81	117									160	550
#25 (CU-40)	4			25	14									95	105
#24 (CU-41)	5			32	18									105	150
#23 (CU-42)	8			46	27									125	240
#18 (CU-51)	60			365	526									350	675
#17 (CU-53)	45			330	190									300	1,350
#21 (CU-57)	18			130	75									180	132
#19 (CU-58)	45			250	145									300	295
#20 (CU-67,71)	41			246	142									290	720
#15 (CU-73,74)	14			82	48									160	110
#14 (CU-82)	3			15	9									90	135
#40 (CU-43,44,45)	47													320	810
#41 (CU-46)	10													135	260
#42 (CU-47)	50													330	450
#43 (CU-48,55,56)	78													440	790
#44 (CU-54)	39													280	90
#45 (CU-62)	38			1,866	1,960									275	600
#46 (CU-66)	37													275	120
#47 (CU-68)	25													215	2,870
#48 (CU-69,70)	103													545	900
#49 (CU-59)	30													240	760
#50 (CU-63)	18													180	675
Sub-Total	732			3,468	3,271									5,390	12,787
In-Basin Totals	1,247			5,489	5,551									10,035	18,092

TABLE VI-5 (Continued)

DETAILED CAPITAL COSTS FOR PLAN 12

FOR FACILITIES RECEIVING: Municipal-Industrial/Combined S.R.O./Municipal S.T.P. Treated S.R.O. ____
Separately Treated S.R.O. Only X

All costs in $1,000

	STORAGE RESERVOIR			LAND TREATMENT SITE			IRRIGATION SYSTEM			DRAINAGE SYSTEM			MISC.	
	17	18	19	20	21	22	23	24	25	26	27	28	29	30
PLANT NAME	Reservoir	Aeration	Chlorination	Purchase and Relocation		Site Preparation	Pump Station	Force Main	Equipment and Distribution Piping	Tile	Conduits and Canals	Sludge Management	Monitoring, Admin. & Labs., Elec.	Total Columns 7-29
CUYAHOGA RIVER														
SWTP #26 (CU-34)	372		17	70		8	26	30	56	29	3		7	
#25 (CU-40)	143		6	8		1	15	18	7	4	1		2	
#24 (CU-41)	176		8	11		1	15	18	9	5	1		2	
#23 (CU-42)	240		10	16		2	20	18	13	7	1		3	
#18 (CU-51)	1,280		56	316		34	50	44	250	131	13		24	
#17 (CU-53)	1,170		52	114		12	48	44	90	48	5		12	
#21 (CU-57)	560		25	45		5	32	30	36	19	2		6	
#19 (CU-58)	950		40	87		9	41	44	69	36	4		10	
#20 (CU-67,71)	950		40	85		9	40	44	67	35	3		9	
#15 (CU-73,74)	375		17	29		3	26	30	24	12	1		5	
#14 (CU-82)	93		4	5		1	10	18	4	2	--		2	
#40 (CU-43,44,45)														
#41 (CU-46)														
#42 (CU-47)														
#43 (CU-48,55,56)														
#44 (CU-54)														
#45 (CU-62)	4,350		250	1,180		127	225	422	422	833	83		91	
#46 (CU-66)														
#47 (CU-68)														
#48 (CU-69,70)														
#49 (CU-59)														
#50 (CU-63)														
Sub-Totals	10,659		525	1,966		212	548	588	1,047	1,161	117		173	
In-Basin Totals	18,563		992	3,366		361	1,170	1,198	1,657	2,052	175		314	

TABLE VI-6
DETAILED OPERATION AND MAINTENANCE COSTS FOR PLAN 12

FOR FACILITIES RECEIVING: Municipal+Industrial/Combined S.R.O./Municipal S.T.P./Treated S.R.O. X
Separately Treated S.R.O. Only. X

PERCENT OF GRAND TOTAL FOR O. & M. COSTS: Municipal and Industrial . . . . ____%
Combined and Separately-Sewered S.R.O. ____%

All costs in $1,000

	BASIC DESIGN DATA					TREATMENT FACILITIES							TRANSMISSION FACILITIES					
1	2	3	4	5	6	7	8	9	10		11	12	13		14	15		16
PLANT NAME	Detention Storage (MG)	Plant Capacity (MGD)	Raw Sludge (TPD)	Winter Storage (MG)	Acres	Detention Storage	Sewers	Pump Station	Plant		Sludge	Total Columns 7-11	Pump Plant		Force Main Drop Shaft Tunnel	Secondary Pump Plant		Force Main
													13A Power	13B Maint & Labor	14 Maintenance & Labor	15A Power	15B Maint & Labor	16 Maintenance & Labor
								10A Preliminary Treatment	10B Aerated Lagoons Power	10C Maint & Labor	10D Disinfection							
IN BASIN																		
Combined: Includes 25.4 ADF (S.W.)		273.83	146.0	31,535	47,579			Included in H&E Costs	2067	2043	999					1519	271	126
Separate Stormwater		77.5			5,551											430	50	90
OUT-OF-BASIN																		
Combined: Includes 22.0 ADF (S.W.)		653.6	349.1	98,700	133,500				4935	4277	1634		1372	193	1703	9804	797	

TABLE VI-6 (Continued)

DETAILED OPERATION AND MAINTENANCE COSTS FOR PLAN 12

FOR FACILITIES RECEIVING: Municipal-Industrial/Combined S.R.O./Municipal S.T.P. Treated S.R.O. X
Separately Treated S.R.O. Only X

All Costs In $1,000

PLANT NAME	STORAGE RESERVOIR					LAND TREATMENT SITE			IRRIGATION SYSTEM				DRAINAGE SYSTEM				MISC.	
	17	18		19		20	21	22	23		24	25	26	27	28		29	30
	Reservoir	Aeration		Chlorination		Purchase and Relocation		Site Preparation	Pump Station		Force Main	Equipment & Distribution Piping	Tile	Conduits & Canals	Sludge Management		Monitoring, Admin. & Labs., Elec.	Total Columns 7-29
	17	18A	18B	19A	19B				23A	23B					28A	28B		
	Maintenance & Labor	Power	Maint. & Labor	Power	Maint. & Labor	No O & M		No O & M	Power	Maint. & Labor	Maintenance & Labor	Maint. & Labor	Maintenance & Labor	Maint. & Labor	Power	Maint. & Labor	Maint. & Labor	
IN BASIN																		
Combined	316	370	378	500					856	138	50	190	190	95	236		230	
Separate Stormwater	92			141					200	58	6	22	22	11			31	
OUT-OF-BASIN																		
Combined	271			1193					2136	174	270	133	601	267	564		832	

ATTACHMENT A

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN
AND THREE RIVERS WATERSHED AREA

U N I T   C O S T S

DEVELOPED BY LAND TREATMENT CONTRACTOR
PHASE II

PREPARED
FOR
U. S. ARMY CORPS OF ENGINEERS
BUFFALO DISTRICT

UNDER CONTRACT NO.: DACW49-72-C-0051

WRIGHT-McLAUGHLIN ENGINEERS
ENGINEERING CONSULTANTS
DENVER, COLORADO
SEPTEMBER 22, 1972
REVISED OCTOBER 6, 1972

UNIT COSTS

Table of Contents

CAPITAL COSTS
LIST OF CURVES
USED FOR COSTING

Cost Component	Curve	Detailed Cost Sheet Column Number
Pump Plant (Station)	A	13 & 15
Force Main	D	14, 16, 24
Drop Shaft	C	14
Tunnel (Lined Mole)	B	14
Secondary Pump Plant	E	15
Lift Shaft	C	15
Aerated Lagoons	G	10
Storage Reservoir or Det'n. Pond	F	17
Chlorination	H	19
Irrigation Pump	I	23
Sludge Storage (In Basin)	K	28
Sludge to Strip Mine Areas	L	28
Sewer	J	

UNIT COSTS

Table of Contents (Cont'd.)

Section

3. Unit Costs

B. Operation & Maintenance Costs - Details of Unit Cost Determinations

Table of Contents (Cont'd.)

ABBREVIATIONS

ADF	=	Average Daily Flow
AR	=	Annual Runoff
MDF	=	Maximum Daily Flow
MF	=	Peak Hourly Flow
MGD	=	Million Gallons Per Day
TDH	=	Total Dynamic Head
TPD	=	Tons Per Day

LAND TREATMENT

SEQUENCE OF COST COMPONENTS *
OF FORMULATED PLANS

Initial Treatment	In-Basin
Final Treatment	In-Basin

* Circled Numbers Refer To Column Numbers On Detailed Cost Sheets

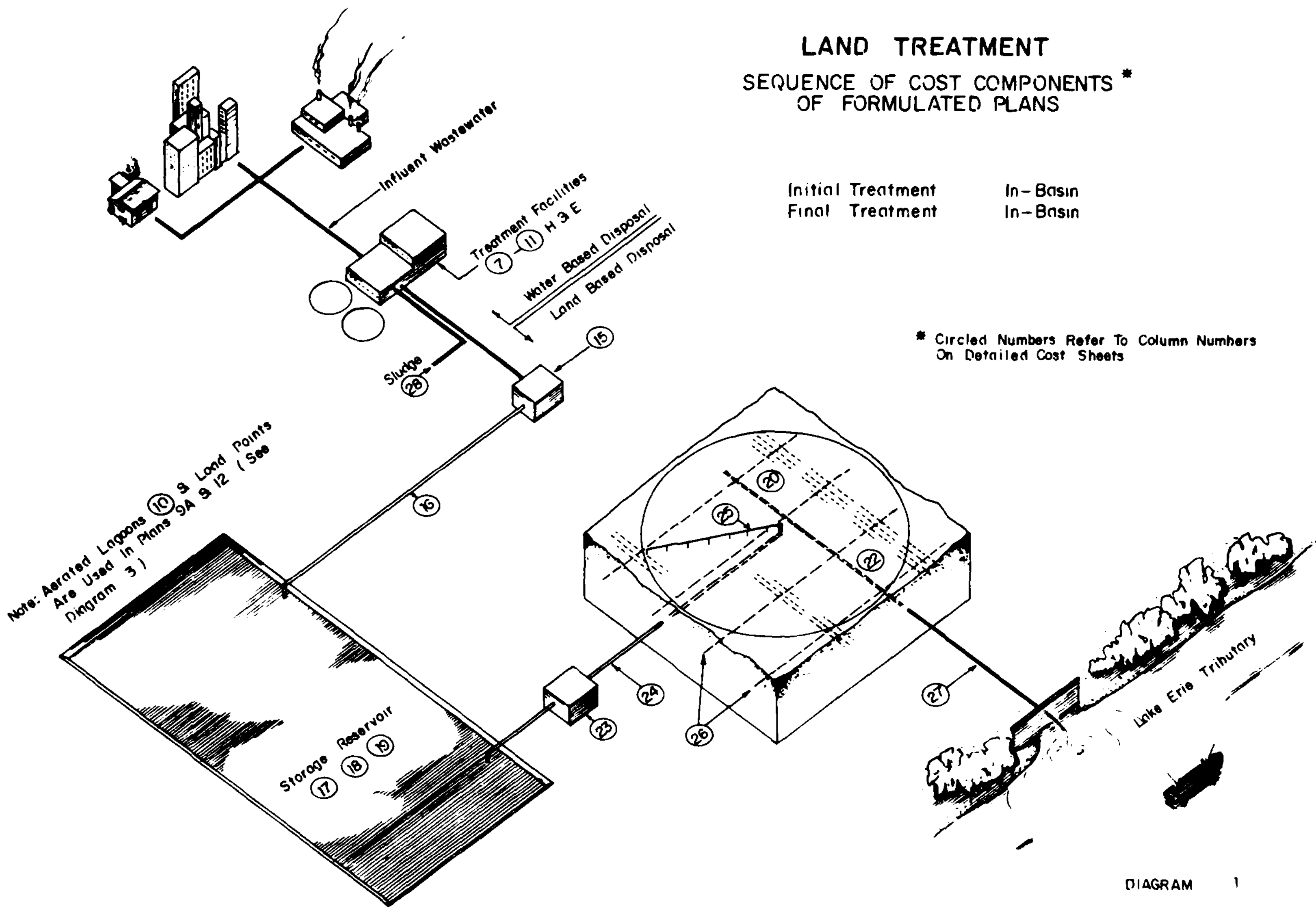


DIAGRAM 1

LAND TREATMENT

SEQUENCE OF COST COMPONENTS *
OF FORMULATED PLANS

Initial Treatment	In-Basin
Final Treatment	Out-of-Basin

* Circled Numbers Refer To Column Numbers On Detailed Cost Sheets

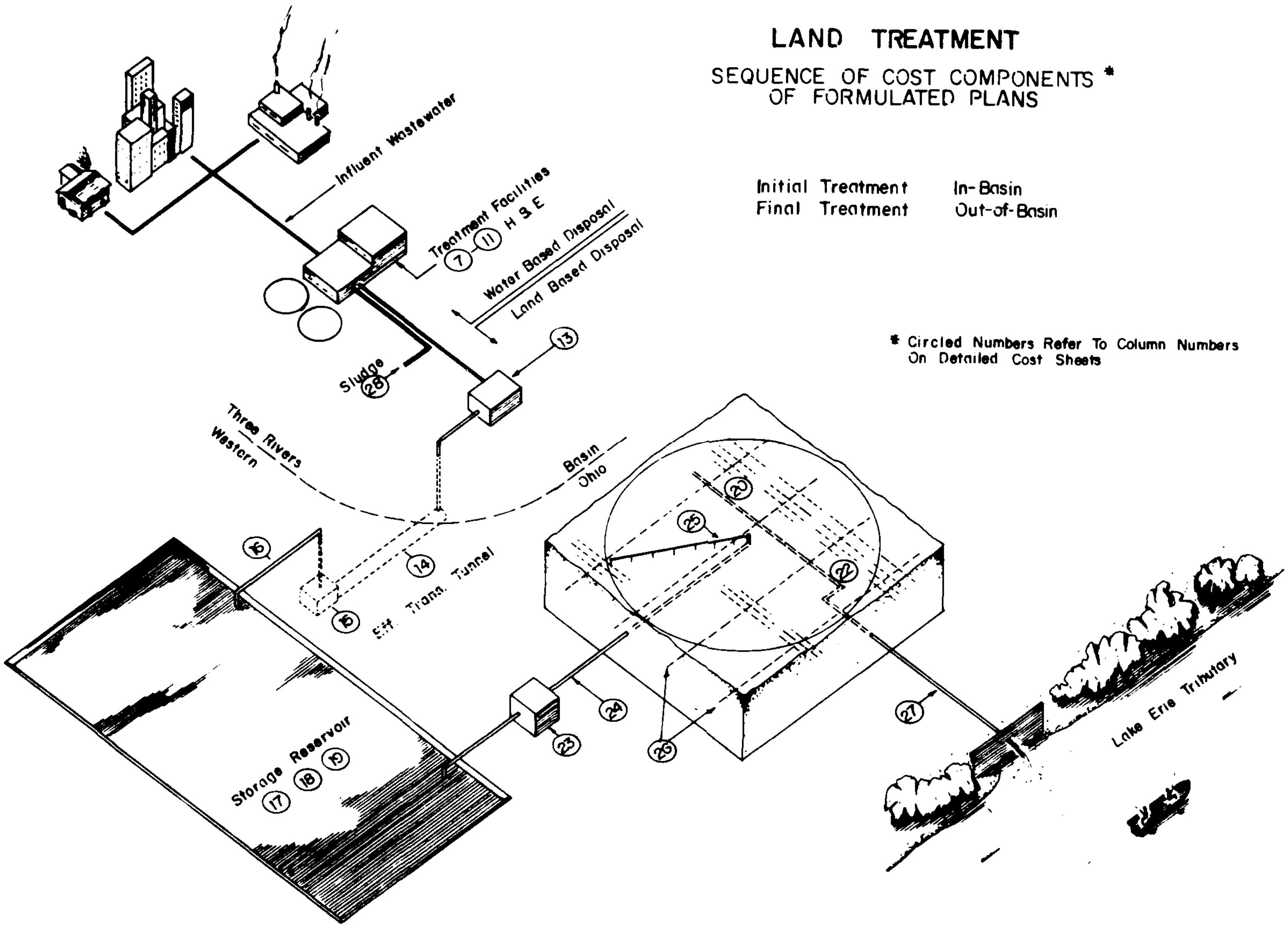


DIAGRAM 2

LAND TREATMENT

SEQUENCE OF COST COMPONENTS*
OF FORMULATED PLANS

Initial Treatment	Out-of-Basin
Final Treatment	Out-of-Basin

* Circled Numbers Refer To Column Numbers On Detailed Cost Sheets

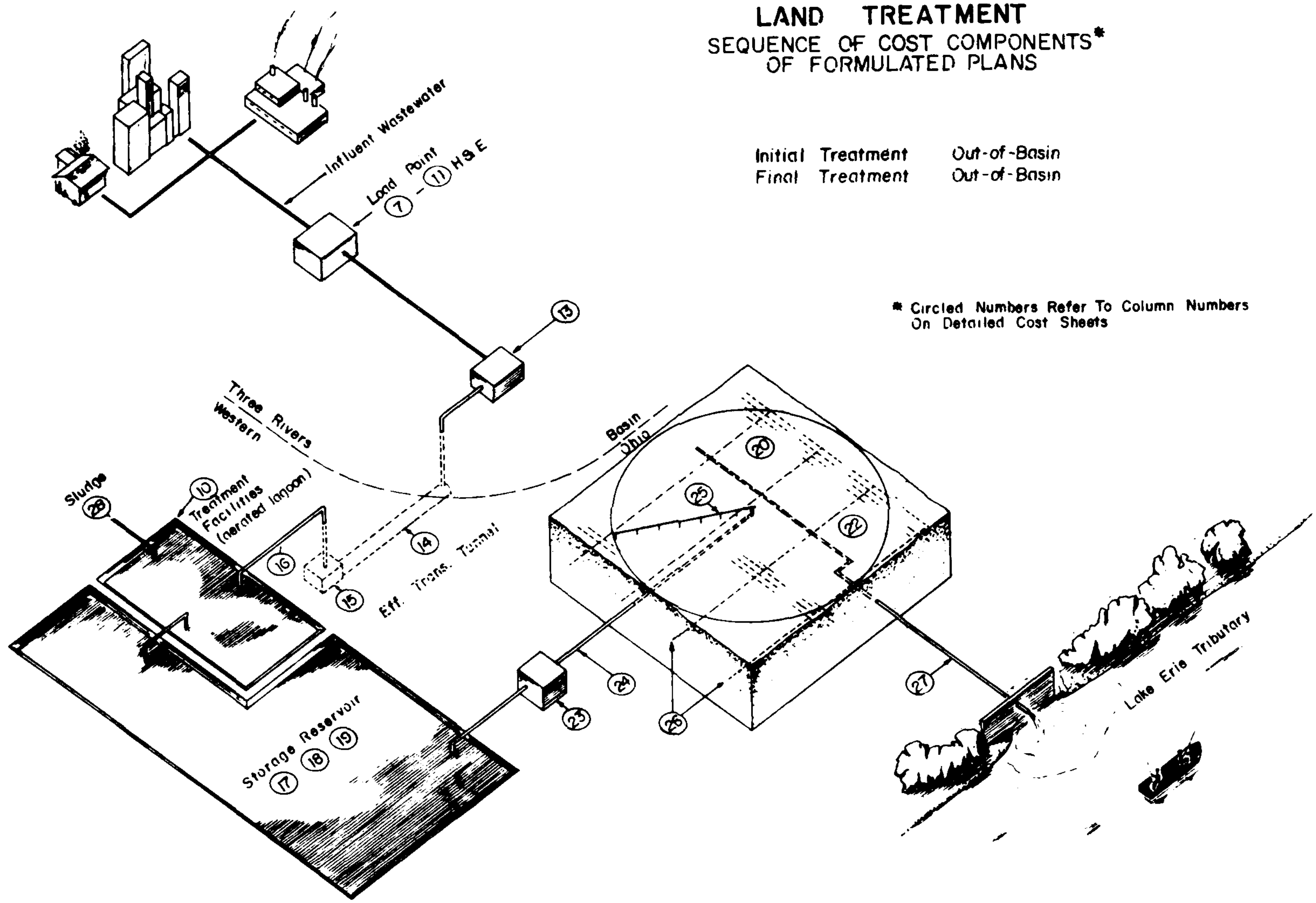


DIAGRAM 3

CAPITAL COSTS

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation — Phase 2 Sub - Item ____

UNIT COST CONTAINED IN DETAILED COSTING SHEETS — SHEET NO. 1 OF 1
FOR COLUMN #: 1-6 — JOB NO. 712-70
ITEM: Basic Data — BY W-ME DATE 9-20-72

A. Cost Type: Capital Cost X Operation & Maintenance (O&M) X
B. General Component Heading:
Transmission Facilities ____ Irrigation System ____
Storage Reservoirs ____ Drainage ____
Land Treatment Site ____ Miscellaneous ____

C. Cost Item: Basic Data (Used in Costing) Column: 1-6
Name

Column No.	Item w/Source of Data and/or Explanation
1	Plant Name
2	Detention Storage (MG) H&E Phase I Report - Part B
3	Plant Capacity (MGD) Wastewater: Municipal Wastewater Flow - H&E Projections Phase I Report, Part A Industrial: AWARE Projections Stormwater: H&E Projections Phase I Report, Part B Conceptualized Plants: W-ME Projections
4	Raw Sludge - H&E (TPD)
5	Winter Storage (MG)

Note: The number of days used to determine the Winter Storage equals 365 days less the number of days of estimated application of wastewater. This can vary depending on the soil type being used for treatment.

a. Sanitary Plant
No. of Days x (ADF) = MG Storage

b. Sanitary Plant with Stormwater
Sanitary + Stormwater = MG Storage
No. of Days x (ADF) + %(AR) = MG Storage

c. Stormwater Plant (two most widely used %'s are shown as examples)
$\frac{155}{365}$ x Annual Runoff = MG Storage
or $\frac{85}{365}$ x Annual Runoff = MG Storage

6 Acres Needed for Treatment

a. Sanitary Plant
(ADF) x 365 x 3.07 $\frac{\text{Acre-ft.}}{\text{MG}}$ / App. Rate = Acres

b. Sanitary Plant with Stormwater
Sanitary Acres + Stormwater Acres
(ADF) x 365 x 3.07 $\frac{\text{Acre-ft.}}{\text{MG}}$ / App. Rate
+ AR x 3.07 $\frac{\text{Acre-ft.}}{\text{MG}}$ / App. Rate = Acres

c. Stormwater Plant
AR x 3.07 $\frac{\text{Acre-ft.}}{\text{MG}}$ / App. Rate = Acres

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase 2   Sub - Item ______

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 1 OF 1
FOR COLUMN #: 7-11   JOB NO. 712-70
ITEM: Treatment (In Plants) (Aerated Lagoon - Col. 10)   BY W-ME   DATE 9-20-72

A. Cost Type: Capital Cost X   Operation & Maintenance (O&M) ____
B. General Component Heading:
Treatment Facilities X   Irrigation System ____
Transmission Facilities ____   Drainage ____
Storage Reservoirs ____   Miscellaneous ____
Land Treatment Site ____

C. Cost Item Treatment (In Plants or Aerated Lagoon)   Column: 7-11
Name

COMPUTATION:

All costs for sewage treatment plants are supplied by Havens & Emerson. For Plan 9A, 3 plants were costed using aerated lagoons rather than secondary treatment in sewage treatment plants. The costs for these aerated lagoons are included in land treatment costs. For Plan 12 all plants were costed using aerated lagoons.

Column 10 in the detailed cost sheets shows aerated lagoon costs and this component cost is shown under the Land Treatment Site heading rather than under Treatment in Plants on the plan cost summary sheets.

Curve G has been plotted to show the capital cost for a wide range of aerated lagoon treatment capacities. The costs shown in column 10 of the detailed cost sheets were selected from Curve G.

EXPLANATION:

REFERENCES:

Havens & Emerson - Secondary, Tertiary and Advanced Wastewater Treatment Plant Costs.
W-ME - Aerated Lagoon Costs

FINAL UNIT COST USED: All costs supplied by Havens & Emerson except as in Plans 9A & 12.

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation Phase: 2 Sub - Item: ______

UNIT COST CONTAINED IN DETAILED COSTING SHEETS SHEET NO. 1 OF 1
FOR COLUMN #: 13 JOB NO. 712-70
ITEM: Pumping Plant to Tunnel/ Force Main BY W-HE DATE 9-20-72

A. Cost Type: Capital Cost X Operation & Maintenance (O&M) ______
B. General Component Heading:
Transmission Facilities X Irrigation System ______
Storage Reservoirs ______ Drainage ______
Land Treatment Site ______ Miscellaneous ______

C. Cost Item Pumping Plant Column: 13
Name

COMPUTATION:

Curve A plots the costs of various size pumping plants as used in the C-SELM project. The costs are based on actual contract experience as well as designs built up from component labor and material costs.

EXPLANATION:

REFERENCES:

OCE Cost Curve - Figure 21-13 as shown in
Bauer, C-SELM Report
(Feb. 1972)

FINAL UNIT COST USED: Curve A Used to Determine Individual Plant Costs

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation　　Phase 2　Sub - Item: ____

UNIT COST CONTAINED IN DETAILED COSTING SHEETS　　SHEET NO. 1 OF 1
FOR COLUMN #: 14, 16 and 24　　JOB NO. 712-70
ITEM: Force Main　　BY W-ME　DATE 9-20-72

A. Cost Type: Capital Cost X　　Operation & Maintenance (O&M) ____

B. General Component Heading:
Transmission Facilities X　　Irrigation System X
Storage Reservoirs ____　　Drainage ____
Land Treatment Site ____　　Miscellaneous ____

C. Cost Item: Force Main (Name)　　Column: 14, 16 and 24

COMPUTATION:

Curve D was plotted from data in the referenced report. Costs of some sizes smaller as well as larger than those shown in the table were then determined by extrapolation

EXPLANATION:

REFERENCES:

OCE Cost Table 21-3 as shown in
Bauer, C-SELM Report
(Feb. 1972)

FINAL UNIT COST USED: Use Curve D to Determine Cost of Various Size Lines

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation Phase: 2 Sub - Item: ____

UNIT COST CONTAINED IN DETAILED COSTING SHEETS SHEET NO. 1 OF 1
FOR COLUMN #: 14 and 15 JOB NO. 712-70
ITEM: Drop Shaft (Lift Shaft) BY GGR DATE 9-14-72

A. Cost Type: Capital Cost X Operation & Maintenance (O&M) ____
B. General Component Heading:
Transmission Facilities X Irrigation System ____
Storage Reservoirs ____ Drainage ____
Land Treatment Site ____ Miscellaneous ____

C. Cost Item: Drop Shaft (Lift Shaft) Column: 14 and 15
Name

COMPUTATION:

Curve C, which is Figure 21-14 from the OCE publication (Task No. 21) of the unit costs developed in the C-SELM, Bauer Engineering Study, is the source of drop shaft and lift shaft unit costs.

EXPLANATION:

REFERENCES:

OCE Cost Figure 21-14 as shown in
Bauer, C-SELM Report
(Feb. 1972)

FINAL UNIT COST USED: Use Curve C to Determine Costs of Various Diameter Shafts

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase 2   Sub - Item

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 1 OF 1

FOR COLUMN #: 14   JOB NO. 712 - 70

ITEM: Tunnel   BY GGR   DATE 9-14-72

A. Cost Type: Capital Cost X   Operation & Maintenance (O&M) ____

B. General Component Heading:

Transmission Facilities X   Irrigation System ____
Storage Reservoirs ____   Drainage ____
Land Treatment Site ____   Miscellaneous ____

C. Cost Item Tunnel   Column: 14
Name

COMPUTATION:

COST PER LINEAL FOOT (Constr. Cost Only)

The ENR Sept. 1970 Engr. Construction Cost Index = 1752 (Cleveland) (used by Dalton-Dalton-Little) On 6-72 the Index = 2025 (Cleveland)

$\frac{2025}{1752} = 1.16$ (Used to adjust D-D&L costs from 1970 - 1972)

Finish Dia.	Adjusted '72 (Cleve) (Rpt) D-D&L	'72 (Ltr) W-C	'72 (C-Selm Rpt) BAUER	AVERAGE	ADJUSTED
8'	280	400	310	330	350
10'	360	450	380	400	400
12'	460	500	440	470	500
14'	570	600	530	570	600
16'	660	650	640	650	650
18'	780	800	750	780	750

All tunnels are lined:

EXPLANATION:

Based on above average costs, it is felt that tunnel costs in "adjusted" column are reasonable to use. This means W-C costs as used before can be reduced $50/ft for the 8', 10', and 18' tunnels. (The 18' tunnel is adjusted to a slightly below the average figure since the original $800 cost was not in the C letter and was subsequently extrapolated at what is now felt to be e more on the high side - $750 probably would have been a more reasonable extrapolation).

REFERENCES: September 1970 - Dalton, Dalton & Little Cleveland Tunnel Report
February 1972 - C-Selm (Bauer) costs as Published by Corps
June 1972 - Woodward-Clevenger & Assoc. Inc. letter to W-ME

USED: See "Adjusted" column. (Curve B was plotted from the costs shown above)
(Revision as of 9-14-72)

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase: 2   Sub - Item: ______

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 1 OF 1
FOR COLUMN #: 15   JOB NO. 712-70
ITEM: Secondary Pump Plant   BY W-ME   DATE 9-20-72

A. Cost Type: Capital Cost X   Operation & Maintenance (O&M) ______
B. General Component Heading:
Transmission Facilities ______   Irrigation System ______
Storage Reservoirs ______   Drainage ______
Land Treatment Site ______   Miscellaneous ______

C. Cost Item: Secondary Pump Plant   Column: 15
Name

COMPUTATION:

Curves A and E both plot the costs of various size pumping plants as used in the C-SELM project. The costs are based on actual contract experience as well as designs built up for specific applications.

Use Curve A for pumping into tunnel or pumping from plant to storage reservoirs.

Use Curve E for pumping out of tunnel.

EXPLANATION:

REFERENCES:

Pumping Station Construction Cost as shown in Cost Data Annex to Technical Appendix C-SELM, Bauer Engineering Report (March, 1972)

Wright-McLaughlin Engineers

FINAL UNIT COST USED: Use Curves A and E to Determine Individual Plant Costs

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase: 2   Sub - Item: ______

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 1 OF 1
FOR COLUMN #: 17   JOB NO. 712-70
ITEM: Storage Reservoirs   BY GGR   DATE 9-15-72

A. Cost Type: Capital Cost X   *Operation & Maintenance (O&M)* ______
B. General Component Heading:
- Transmission Facilities ______
- Storage Reservoirs X
- Land Treatment Site ______
- Irrigation System ______
- Drainage ______
- Miscellaneous ______

C. Cost Item: Storage Reservoirs (Name)   Column: 17

COMPUTATION:

	STORAGE VOLUME	COST/MG	ADJUSTED COST/MG (25% contingency Removed)	
Based on sample designs and co: ing	10 MG	$8,200 x 0.8 =	$6,560	
	540 MG	4,000 x 0.8 =	3,200	
	12,500 MG	1,275 x 0.8 =	1,020	use $1,000/MG min
	50,000 MG (4 cells)	1,230 x 0.8 =	985	
	100,000 (8 cells)		700	) Estimated based on Bauer cost experience
	150,000 (12 cells)		500	)

Land costs and site preparation included in above. Tight soils should not require lining.

EXPLANATION: NOTE: Costing is to be done so that any contingency factor which is applied is added at the very end and to the total cost rather than to individual items comprising the composite estimate.

Storage reservoirs had a 25% contingency added in as used in previous estimates -- this 25% is now removed!

Chicago-Selm Reservoir cost of $363/MG based on adjusted bidding experience at Muskegon (C-Selm Res. is 369,000 MG)
(in 8 cells @ 46,000 MG per cell)

REFERENCES:
Wright-McLaughlin Engineers - cost comps.
Bauer Engr'ng costs based on Muskegon and other data.

FINAL UNIT COST USED: As shown in adjusted col. above and as plotted for W-ME curve titled "Storage Reservoirs & Det'n Ponds - Capital Costs".

(Revision as of 9-14-72)

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation Phase: 2 Sub - Item: ____

UNIT COST CONTAINED IN DETAILED COSTING SHEETS SHEET NO. 1 OF 1

FOR COLUMN #: 18 JOB NO. 712 - 70

ITEM: AERATION BY RMcL DATE 8-11-72

A. Cost Type: Capital Cost X Operation & Maintenance (O&M) ____

B. General Component Heading:

Transmission Facilities ____ Irrigation System ____

Storage Reservoirs X Drainage ____

Land Treatment Site ____ Miscellaneous ____

C. Cost Item: Aeration (Name) Column: 18

COMPUTATION:

For emergency - supplemental storage aeration. Prototype 5 MG module @ 20' Depth (avg)
Area = 31,400 s.f. or R = 100' (ok for area of influence)

Avg BOD_5 = 12 mg/l or BOD_u = 20 mg/l

Say satisfy by feed @ 2 mg/l/day maximum rate

#/day for 5 MG = 40 #/day/unit =<2.0 $\#O_2$/hr

Way low: Mixing intensity will govern. Normal for D. O. mix = 6-8 HP/MG
With small units, reasonable D.O. mix (at surface only) can be done
w/about 1.0 HP/MG.
5 HP unit w/cables & elect. = $3,500
$3,500/5 MG = $700/MG

EXPLANATION:

REFERENCES:

Wright-McLaughlin Engineers

FINAL UNIT COST USED: $700/MG

Land Treatment/Formulation   Phase 2   Sub - Item

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 1 OF 1
FOR COLUMN #: 19   JOB NO. 712-70
ITEM: Chlorination   BY W-ME   DATE 9-20-72

A. Cost Type: Capital Cost X   Operation & Maintenance (O&M) ____
B. General Component Heading:
Transmission Facilities ____   Irrigation System ____
Storage Reservoirs X   Drainage ____
Land Treatment Site ____   Miscellaneous ____

C. Cost Item Chlorination   Column: 19
Name

COMPUTATION:

Curve H is as supplied by Havens and Emerson.

EXPLANATION:

REFERENCES:

Havens & Emerson

FINAL UNIT COST USED: Use Curve H to determine Chlorination cost for Various Plant Sizes.

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation Phase: 2 Sub - Item: ____________

UNIT COST CONTAINED IN DETAILED COSTING SHEETS SHEET NO. 1 OF 1

FOR COLUMN #: 20 JOB NO. 712 - 70

ITEM: Purchase & Relocation BY KRW DATE 9-14-72

A. Cost Type: Capital Cost X Operation & Maintenance (O&M) ____

B. General Component Heading:
Transmission Facilities ____ Irrigation System ____
Storage Reservoirs ____ Drainage ____
Land Treatment Site X Miscellaneous ____

C. Cost Item: Purchase & Relocation Column: 20
Name

COMPUTATION:

Purchase Land Cost - Average $334.00/Acre (page 3 of letter from Dept. of Army - see reference below)

Family Relocation Cost:
Average Farm = 80 acres - based on listed averages
Cost for 1 unit of farm buildings = $16,000
Relocation Cost - $5,000

Total Relocation Cost for One Family	Relocation Cost Per Acre	Total Purchase & Relocation Cost Per Acre:
$16,000	= $21,000/80 acres	$334/Ac. Raw purchase
5,000	= $262.50/Ac.	$262/Ac. Relocation
$21,000		$596/Ac.

EXPLANATION:

Method: Each County priced by township ($/acre)
Cost ($/acre) averaged for each county
Average cost ($/acre) for all counties = $334/acre - See resume, page 3 of letter
Average relocation cost = $262.50/acre - see above or page 4 of letter
Total Estimated Cost Per Acre = $600/acre
(With 15% variation allowance = $700/acre - page 4 of letter)

REFERENCES: Dept. of The Army
North Central Division, Corps of Engineers
536 S. Clark Street
Chicago, Illinois 60605
By letter - July 24, 1972/Management & Disposal Branch, Real Estate Div.

FINAL UNIT COST USED: $600/Acre (does not include any contingency)
Revision as of 9-14-72

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase: 2   Sub - Item: ______

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 1 OF 1
FOR COLUMN #: 21   JOB NO. 712-70
ITEM: Revision - Farm Equipment   BY W-ME DATE 9-14-72

A. Cost Type: Capital Cost X   Operation & Maintenance (O&M) ______
B. General Component Heading:
Transmission Facilities ______   Irrigation System ______
Storage Reservoirs ______   Drainage ______
Land Treatment Site X   Miscellaneous ______

C. Cost Item Farm Equipment (Name)   Column: 21

COMPUTATION:

Do not include this in cost summary. This item originally estimated at $100/ac. is a cost of doing business. It more appropriately should be considered as a deduct from farm income, along with labor, chemicals, gas, oil, and vehicles.

Net farm income estimates can be more readily referenced to by leaving out of estimate.

EXPLANATION:

Land management has been investigated in detail with regard to specific crops, type of application, type of drainage, etc. Costs of irrigation equipment and drainage reflect land management techniques required initially such as surface preparation and specialized deep plowing.

REFERENCES: Wright McLaughlin Engineers

FINAL UNIT COST USED: Drop Farm Equipment Cost (Revision as of 9-14-72)

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase: 2   Sub - Item: ______

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 1 OF 1
FOR COLUMN #: 22   JOB NO. 712 - 70
ITEM: Site Preparation (Revised)   BY W-ME   DATE 9-14-72

A. Cost Type: Capital Cost X   Operation & Maintenance (O&M) ______
B. General Component Heading:
Transmission Facilities ______   Irrigation System ______
Storage Reservoirs ______   Drainage ______
Land Treatment Site X   Miscellaneous ______

C. Cost Item Site Preparation (Name)   Column: 22

COMPUTATION:

1)	Woodland clearing	$35/acre
2)	Miscellaneous site preparation such as fences, removals, site work	20/acre
3)	Access roads	5/acre
4)	Miscellaneous grading for operation	5/acre
		$65/acre

$65/acre is basic site preparation. Specialized site preparation to be included in irrigation equipment.

Note: Relocation costs and purchase of farm buildings included in cost of land at $700/acre (includes 15% contingency factor included by Chicago Division). Thus, use $600/acre in computations for land purchase and relocation. Families not moved from site would tend to lower land costs.

EXPLANATION:

1) Woodland clearing computed at 10% of total area at $350/acre. Much of woodland will not be cleared, however.
2) Includes removal of buildings which would conflict with operations.
3) Access roads would be in addition to existing roads, for access to operational points of irrigation and drainage facilities.
4) This includes grading for irrigation facilities, access roads, etc.. For specialized irrigation and application techniques, additional site preparation will be included under irrigation equipment.

REFERENCES: Reservoir clearing experience in Colorado - Wright - McLaughlin Engineers
"Cost Summary for Land Treatment" ($82/acre)
"Muskegon Contract No. 1"
C - SEEM Report - Technical Appendix (Cost Data Annex)
March, 1972

FINAL UNIT COST USED: $65/acre
(Revision as of 9-14-72)

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation Phase: 2 Sub - Item: ______

UNIT COST CONTAINED IN DETAILED COSTING SHEETS

FOR COLUMN #: 23 SHEET NO. 1 OF 1

JOB NO. 71 2 - 70

ITEM: Pump Station BY W-ME DATE 9-20-72

A. Cost Type: Capital Cost X Operation & Maintenance (O&M) ______

B. General Component Heading:

Transmission Facilities ______ Irrigation System X
Storage Reservoirs ______ Drainage ______
Land Treatment Site ______ Miscellaneous ______

C. Cost Item Pump Station Column: 23
Name

COMPUTATION:

Curve I is based on construction cost experience.

EXPLANATION:

REFERENCES:
U. S. Bureau of Reclamation
Wright-McLaughlin Engineers

FINAL UNIT COST USED: Use Curve I to Determine Individual Plant Costs

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase: 2   Sub - Item: ____

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 1 OF 6
FOR COLUMN #: 25   JOB NO. 71 2 - 70
ITEM: EQUIPMENT & DISTRIBUTION PIPING - MAHONING SOILS MINI-BORDER SYSTEM   BY W-ME   DATE 9/18/72

A. Cost Type: Capital Cost X   Operation & Maintenance (O&M) ____
B. General Component Heading:
Transmission Facilities ____   Irrigation System X
Storage Reservoirs ____   Drainage ____
Land Treatment Site ____   Miscellaneous ____

C. Cost Item: EQUIPMENT & DISTRIBUTION PIPING (Name)   Column: 25

COMPUTATION: MAHONING SOILS - MINI-BORDER SYSTEM

For application rates of 90 inches/year (municipal effluent) or 150 inches/year (separate storm runoff).

Automated farm distribution equipment (25-year life) . . $150/acre

Site Preparation:

Forming . . . . $ 10/acre

Soil preparation and seeding . . . . $ 15/acre

Deep plowing on contour . . . . $ 40/acre

$215/acre

EXPLANATION:

REFERENCES: Donald L. Miles, Irrigation Specialist, Agricultural Engineering Dept. Colorado State University
Wright-McLaughlin Engineers
Valmont Industries, Inc., Valley, Nebraska
IRECO Industries, Inc., Eugene, Oregon
ENRESCO, Colorado Springs, Colorado
Rain Bird Sprinkler Manufacturing Corp., Glendora, California

FINAL UNIT COST USED: $215/acre

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase: 2   Sub - Item:

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 2 OF 6
FOR COLUMN #: 25   JOB NO. 712-70
ITEM: EQUIPMENT DISTRIBUTION PIPING-CHILI & RELATED SOILS IN-BASIN   BY W-ME   DATE 9/18/72

A. Cost Type: Capital Cost X   Operation & Maintenance (O&M)
B. General Component Heading:
Transmission Facilities   Irrigation System X
Storage Reservoirs   Drainage
Land Treatment Site   Miscellaneous

C. Cost Item: EQUIPMENT & DISTRIBUTION PIPING   Column: 25
Name

COMPUTATION: CHILI AND RELATED SOILS IN-BASIN

For application rate of 60 inches/year.

Use solid-set system.

Sprinklers . . . . $ 300/acre
Distribution System . . . . $ 175/acre

$475/acre

EXPLANATION:

REFERENCES: Donald L. Miles, Irrigation Specialist, Agricultural Engineering Dept. Colorado State University
Wright-McLaughlin Engineers
Valmont Industries, Inc., Valley, Nebraska
IRECO Industries, Inc., Eugene, Oregon
ENRESCO, Colorado Springs, Colorado
Rain Bird Sprinkler Manufacturing Corp., Glendora, California

FINAL UNIT COST USED: $ 475/acre

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase: 2   Sub - Item:

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 3 OF 6
FOR COLUMN #: 25   JOB NO 712 - 70
ITEM: EQUIPMENT & DISTRIBUTION PIPING - CARDINGTON-BENNINGTON SOILS (COMPOSITE)   BY W-ME   DATE 9/18/72

A. Cost Type: Capital Cost X   Operation & Maintenance (O&M)

B. General Component Heading:
Transmission Facilities   Irrigation System X
Storage Reservoirs   Drainage
Land Treatment Site   Miscellaneous

C. Cost Item: EQUIPMENT & DISTRIBUTION PIPING   Column: 25
Name

COMPUTATION: CARDINGTON - BENNINGTON SOILS
(COMPOSITE OF WESTERN AREAS)

Mini-Border	5%	0.05	(175) =	9
Hay & Pasture	30%	0.30	(475) =	142
Corn (Pivot Rigs)	65%	0.65	(320) =	208
				359

USE $360/Acre

EXPLANATION:

REFERENCES: Donald L. Miles, Irrigation Specialist, Agricultural Engineering Dept.
Colorado State University
Wright-McLaughlin Engineers
Valmont Industries, Inc., Valley, Nebraska
IRECO Industries, Inc., Eugene, Oregon
ENRESCO, Colorado Springs, Colorado
Rain Bird Sprinkler Manufacturing Corp., Glendora, California

FINAL UNIT COST USED: $360/Acre

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase: 2   Sub - Item: ______

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 4 OF 6
FOR COLUMN #: 25   JOB NO. 712-70
ITEM: EQUIPMENT & DISTRIBUTION PIPING - CARDINGTON-BENNINGTON SOILS   BY RLT   DATE 9/18/72

A. Cost Type: Capital Cost X   Operation & Maintenance (O&M) ______
B. General Component Heading:
   Transmission Facilities ______   Irrigation System X
   Storage Reservoirs ______   Drainage ______
   Land Treatment Site ______   Miscellaneous ______

C. Cost Item: EQUIPMENT & DISTRIBUTION PIPING   Column: 25
   Name

COMPUTATION: CARDINGTON-BENNINGTON SOILS

For application rate of 75 inches/year on corn with drip tubes on rigs. On 160 acres one large rig irrigates 122 acres.

Cost of Pivot Rig: $23,000

Cost per acre: $23,000/122 acres = $190/acre Use: $200/acre

Cost of Piping $100/acre

Circular Plowing with roads and gully crossing . . . $ 20/acre

$320/acre

EXPLANATION:

REFERENCES: Donald L. Miles, Irrigation Specialist, Agricultural Engineering Dept., Colorado State University
Wright-McLaughlin Engineers
Valmont Industries, Inc., Valley, Nebraska
IRECO Industries, Inc., Eugene, Oregon
ENRESCO, Colorado Springs, Colorado
Rain Bird Sprinkler Manufacturing Corp., Glendora, California

FINAL UNIT COST USED: $320/acre

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase: 2   Sub - Item: ____

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 5 OF 6
FOR COLUMN #: 25   JOB NO. 712 - 70
ITEM: EQUIPMENT & DISTRIBUTION PIPING - CARDINGTON-BENNINGTON SOILS   BY RLT   DATE 9/18/72

A. Cost Type: Capital Cost X   Operation & Maintenance (O&M) ____
B. General Component Heading:
Transmission Facilities ____   Irrigation System X
Storage Reservoirs ____   Drainage ____
Land Treatment Site ____   Miscellaneous ____

C. Cost Item: EQUIPMENT & DISTRIBUTION PIPING (Name)   Column: 25

COMPUTATION: CARDINGTON-BENNINGTON SOILS

For application rate of 50 inches/year using solid-set system.

Cost of Sprinklers $300/acre
Cost of Distribution System. $175/acre
$475/acre

EXPLANATION:

REFERENCES: Donald L. Miles, Irrigation Specialist, Agricultural Engineering Dept., Colorado State University
Wright-McLaughlin Engineers
Valmont Industries, Inc., Valley, Nebraska
IRECO Industries, Inc., Eugene, Oregon
ENRESCO, Colorado Springs, Colorado
Rain Bird Sprinkler Manufacturing Corp., Glendora, California

FINAL UNIT COST USED: $475/acre

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CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA. W--ETC(U)

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WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation — Phase: 2 — Sub - Item:

UNIT COST CONTAINED IN DETAILED COSTING SHEETS — SHEET NO. 6 OF 6
FOR COLUMN #: 25 — JOB NO. 712-70
ITEM: EQUIPMENT & DISTRIBUTION PIPING - CARDINGTON-BENNINGTON SOILS - MINI BORDER — BY RLT — DATE 9/18/72

A. Cost Type: Capital Cost X Operation & Maintenance (O&M) ____
B. General Component Heading:
Transmission Facilities ____ Irrigation System X
Storage Reservoirs ____ Drainage ____
Land Treatment Site ____ Miscellaneous ____

C. Cost Item: EQUIPMENT & DISTRIBUTION PIPING (Name) Column: 25

COMPUTATION:

CARDINGTON-BENNINGTON SOILS - MINI-BORDER SYSTEM

Automated Farm Distribution. $150/acre

Site Preparation

Forming . . . . $ 10/acre

Soil Preparation and Seeding. . . . . . . $ 15/acre

$175/acre

EXPLANATION:

REFERENCES: Donald L. Miles, Irrigation Specialist, Agricultural Engineering Dept., Colorado State University
Wright-McLaughlin Engineers
Valmont Industries, Inc., Valley, Nebraska
IRECO Industries, Inc., Eugene, Oregon
ENRESCO, Colorado Springs, Colorado
Rain Bird Sprinkler Manufacturing Corp., Glendora, California

FINAL UNIT COST USED: $175/acre

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation Phase: 2 Sub - Item: ______

UNIT COST CONTAINED IN DETAILED COSTING SHEETS SHEET NO. 1 OF 6
FOR COLUMN #: 26 JOB NO. 71-2-70
ITEM: Tile - Mahoning Soils - Mini-Border BY RLT DATE 9-18-72

A. Cost Type: Capital Cost X Operation & Maintenance (O&M) ____
B. General Component Heading:
Transmission Facilities ____ Irrigation System ____
Storage Reservoirs ____ Drainage X
Land Treatment Site ____ Miscellaneous ____

C. Cost Item: Tile - Mahoning Soils Column: 26
Name

COMPUTATION:

MAHONING SOILS: MINI-BORDER SYSTEM

For stormwater use 150"/yr. application rate.
For sanitary sewage use 90"/yr. application rate.

Spacing = 20'
Total length = 2180'

Total cost of tile (2180') = \$328/acre
Collectors and structures = \$ 95/acre
\$423/acre

Use \$425/acre

EXPLANATION:

See above: Tile costs are based on agricultural costs in 1972 as determined by survey and major checking w/Agricultural Engineers, including several at Ohio State University.

REFERENCES:

Donald L. Miles - Agricultural Extension Agent for Colorado
Wright-McLaughlin Engineers

FINAL UNIT COST USED: \$425/acre (MAHONING SOILS: MINI-BORDER SYSTEM)

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase: 2   Sub - Item: ______

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 2 OF 6
FOR COLUMN #: 26   JOB NO. 712-70
ITEM: Tile - Cardington-Bennington Soils   BY RLT   DATE 9-18-72

A. Cost Type: Capital Cost X   Operation & Maintenance (O&M) ______
B. General Component Heading:
Transmission Facilities ______   Irrigation System ______
Storage Reservoirs ______   Drainage X
Land Treatment Site ______   Miscellaneous ______

C. Cost Item: Tile - Cardington-Bennington Soils (Name)   Column: 26

COMPUTATION:

CARDINGTON-BENNINGTON SOILS -- CORN

Use application rate of 75"/yr.

Spacing = 20'

Total length = $\frac{209}{20}$ (209) = 2180 l.f.

Total cost of tile (2180') = $480/acre
Add $70/acre for collectors, structures, etc. = $ 70/acre
$550/acre
Deduct 10% for existing tiles = - 55/acre
$495/acre

Net cost/acre = $495/acre

EXPLANATION:

See above: Tile costs are based on agricultural costs in 1972 as determined by survey and major checking w/Agricultural Engineers, including several at Ohio State University.

REFERENCES:

Donald L. Miles - Agricultural Extension Agent for Colorado
Wright-McLaughlin Engineers

FINAL UNIT COST USED: $495/acre (CARDINGTON-BENNINGTON SOILS--CORN)

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase: 2   Sub - Item: ______

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 3 OF 6
FOR COLUMN #: 26   JOB NO. 712 - 70
ITEM: Tile - Cardington-Bennington Soils--Hay & Pasture   BY RLT   DATE 9-18-72

A. Cost Type: Capital Cost X   Operation & Maintenance (O&M) ______
B. General Component Heading:
Transmission Facilities ______   Irrigation System ______
Storage Reservoirs ______   Drainage X
Land Treatment Site ______   Miscellaneous ______

C. Cost Item: Tile - Cardington-Bennington Soils   Column: 26
Name

COMPUTATION:

CARDINGTON-BENNINGTON SOILS--HAY & PASTURE

Use application rate of 50"/yr.

Spacing = 30'

Length = $\frac{209}{30}$ (209) = 1450 l.f.

Total cost of tile (1450')	=	\$320/acre
Add \$70/acre for collectors, structures, etc.	=	\$ 70/acre
		\$390/acre
Deduct 10% for existing tiles	=	- 40/acre
Net cost/acre	=	\$350/acre

EXPLANATION:

See above: Tile costs are based on agricultural costs in 1972 as determined by survey and major checking w/Agricultural Engineers, including several at Ohio State University.

REFERENCES:

Donald L. Miles - Agricultural Extension Agent for Colorado
Wright-McLaughlin Engineers

FINAL UNIT COST USED: \$350/acre (CARDINGTON-BENNINGTON SOILS--HAY & PASTURE)

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase: 2   Sub - Item.

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 4 OF 6
FOR COLUMN #: 26   JOB NO. 712-70
ITEM: Tile - Cardington-Bennington Soils--Composite Out-of-Basin   BY RIT   DATE 9-18-72

A. Cost Type: Capital Cost X   Operation & Maintenance (O&M)
B. General Component Heading:
Transmission Facilities   Irrigation System
Storage Reservoirs   Drainage X
Land Treatment Site   Miscellaneous

C. Cost Item: Tile - Cardington-Bennington Soils (Name)   Column: 26

COMPUTATION:

CARDINGTON-BENNINGTON SOILS--COMPOSITE OF WESTERN LAND AREAS

Mini-border	5%	=	.05(350)	=	$ 18/acre
Hay & Pasture	30%	=	.30(350)	=	$105/acre
Corn (pivot rigs)	65%	=	.65(495)	=	$322/acre
				TOTAL	$445/acre

EXPLANATION:

See above: Tile costs are based on agricultural costs in 1972 as determined by survey and major checking w/Agricultural Engineers, including several at Ohio State University.

REFERENCES:

Donald L. Miles - Agricultural Extension Agent for Colorado
Wright-McLaughlin Engineers

FINAL UNIT COST USED: $445/acre (CARDINGTON-BENNINGTON SOILS--COMPOSITE)

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase: 2   Sub - Item: ______

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 5 OF 6
FOR COLUMN #: 26   JOB NO. 712 - 70
ITEM: Tile - Cardington-Bennington Soils--Mini-Border System   BY RLT   DATE 9-18-72

A. Cost Type: Capital Cost X   Operation & Maintenance (O&M) ______
B. General Component Heading:
Transmission Facilities ______   Irrigation System ______
Storage Reservoirs ______   Drainage X
Land Treatment Site ______   Miscellaneous ______

C. Cost Item: Tile - Cardington-Bennington Soils (Name)   Column: 26

COMPUTATION:

CARDINGTON-BENNINGTON SOILS--MINI-BORDER CONCEPT

Use 30' spacing.
Same as Hay & Pasture.

EXPLANATION:

See above: Tile costs are based on agricultural costs in 1972 as determined by survey and major checking w/Agricultural Engineers, including several at Ohio State University.

REFERENCES:

Donald L. Miles - Agricultural Extension Agent for Colorado
Wright-McLaughlin Engineers

FINAL UNIT COST USED: $350/acre (CARDINGTON-BENNINGTON SOILS--MINI-BORDER CONCEPT)

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation — Phase: 2 — Sub - Item: ______

UNIT COST CONTAINED IN DETAILED COSTING SHEETS — SHEET NO. 6 OF 6
FOR COLUMN #: 26 — JOB NO. 712 - 70
ITEM: Tile - Chili Soils — BY RLT DATE 9-18-72

A. Cost Type: Capital Cost X Operation & Maintenance (O&M) ______
B. General Component Heading:
Transmission Facilities ______ Irrigation System ______
Storage Reservoirs ______ Drainage X
Land Treatment Site ______ Miscellaneous ______

C. Cost Item: Tile - Chili Soils (Name) Column: 26

COMPUTATION:

CHILI SOILS

Use application rate of 60"/yr.

Use spacing of 60' @ $5\frac{1}{2}$-foot depth

Length = $\frac{43,560}{60}$ = 726 ft.

Cost of 4" Tile (726')	= $290/acre
Add $90/acre for collectors, structures, etc.	= $ 90/acre
TOTAL	$380/acre

EXPLANATION:

All of the Chili soils may not require tile drainage, depending on the topography. For example, on steep terrain tile drainage may be limited to the low-lying lands.

REFERENCES:

Table III, Practical Installation of Clay, Concrete and Corrugated Plastic Subsurface Drains, by Lyman S. Willardson. Also conversation with Dr. Willardson.

FINAL UNIT COST USED: $380/acre (CHILI SOILS)

27

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase: 2   Sub - Item:

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 1 OF 1
FOR COLUMN #: 27   JOB NO. 71 - 70
ITEM: Conduits and Canals   BY KRW   DATE 9-16-72

A. Cost Type: Capital Cost X   Operation & Maintenance (O&M)
B. General Component Heading:
Transmission Facilities   Irrigation System
Storage Reservoirs   Drainage X
Land Treatment Site   Miscellaneous

C. Cost Item Conduits and Canals (Name)   Column: 27

COMPUTATION:

Cost of construction will be an average of $25/acre over and above drainage unit costs.

EXPLANATION:

Conduits will be required to convey return flow to suitable discharge points. Canals will be used where volumes are large. Hydrological studies in western Ohio show stream regimes to be generally suitable.

REFERENCES:

Based on evaluation of typical units and topographical maps, and on hydrological study of streams.

FINAL UNIT COST USED CAPITAL COST: $25/acre

(Revision as of 9-14-72)

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation Phase 2 Sub - Item

UNIT COST CONTAINED IN DETAILED COSTING SHEETS

SHEET NO. 1 OF 2

FOR COLUMN #: 28

JOB NO. 12 - 70

ITEM: Sludge Management (In-Basin)

BY LAL DATE 9-21-72

A. Cost Type: Capital Cost X Operation & Maintenance (O&M)

B. General Component Heading:

Transmission Facilities Irrigation System
Storage Reservoirs Drainage
Land Treatment Site Miscellaneous

C. Cost Item Sludge Management (In-Basin) Column: 28
Name

COMPUTATION:

Costs based upon the storage capacity needed for winter months. (No costs were included for land or equipment as they are included under land acquisition and treatment costs.)

EXPLANATION:

Sludge produced was converted to gallonage. Use Curve K to obtain cost at that volume.

REFERENCES:

Wright-McLaughlin Engineers

FINAL UNIT COST USED: Use Curve K to Determine Costs of Sludge Management Facilities In-Basin.

Land Treatment/Formulation — Phase 2 — Sub-Item:

UNIT COST CONTAINED IN DETAILED COSTING SHEETS — SHEET NO. 2 OF 2

FOR COLUMN #: 28 — JOB NO. 712-70

ITEM: Sludge Management (Strip Mined Areas) — BY LAL — DATE 9-21-72

A. Cost Type: Capital Cost X Operation & Maintenance (O&M) ____

B. General Component Heading:

Transmission Facilities ____ Irrigation System ____
Storage Reservoirs ____ Drainage ____
Land Treatment Site ____ Miscellaneous ____

C. Cost Item Sludge Management (Strip M.Areas) Column: 28
Name

COMPUTATION:

EXPLANATION:

Capital Cost for sludge management to STRIP MINED AREAS based on:

1. Pipeline Easement
2. Pipeline
3. Pump Stations
4. Storage Reservoirs
5. Distribution Piping
6. Trucks
7. Application Equipment

REFERENCES:

"Bulk Transport of Waste Slurries to Inland and Ocean Disposal Sites," Bechtel Corporation, Sept. 1969
Wright-McLaughlin Engineers

FINAL UNIT COST USED: Use Curve L to Determine Cost of Facilities for Sending Sludge to Strip Mined Areas.

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase 2   Sub - Item.

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 1 OF 1

FOR COLUMN #: 29   JOB NO. 712-70

ITEM: Miscellaneous   BY KRW   DATE 9-16-72

A. Cost Type: Capital Cost X   Operation & Maintenance (O&M)

B. General Component Heading:

- Transmission Facilities
- Storage Reservoirs
- Land Treatment Site
- Irrigation System
- Drainage
- Miscellaneous X

C. Cost Item Miscellaneous (Name)   Column: 29

COMPUTATION:

Computed at 5 percent of irrigation & drainage capital costs. (Cols. 23 thru 27)

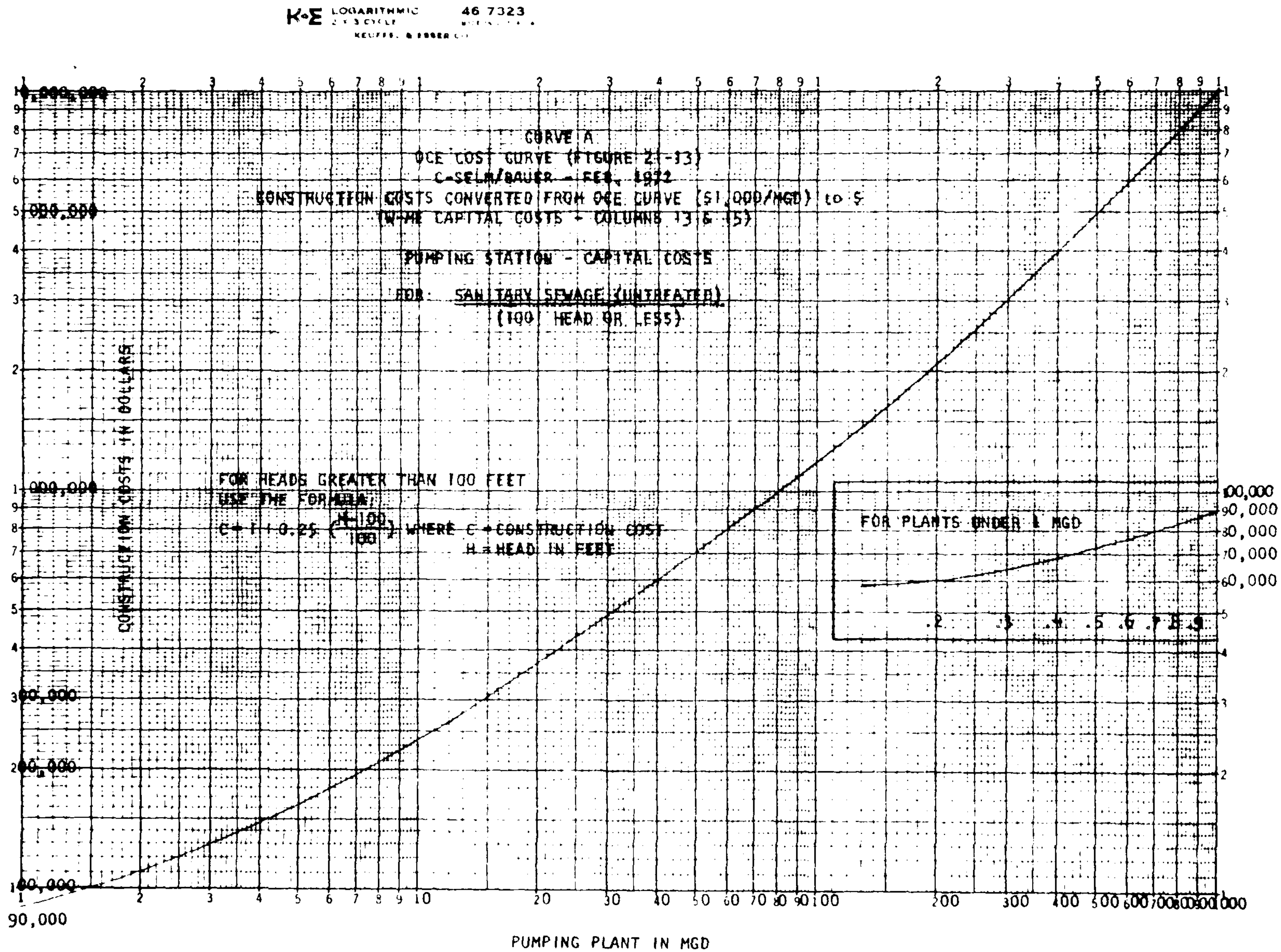
EXPLANATION:

Miscellaneous includes capital cost for administration building, monitoring holes for ground water, also outside electrical costs not already included in other major components and laboratories.

REFERENCES:

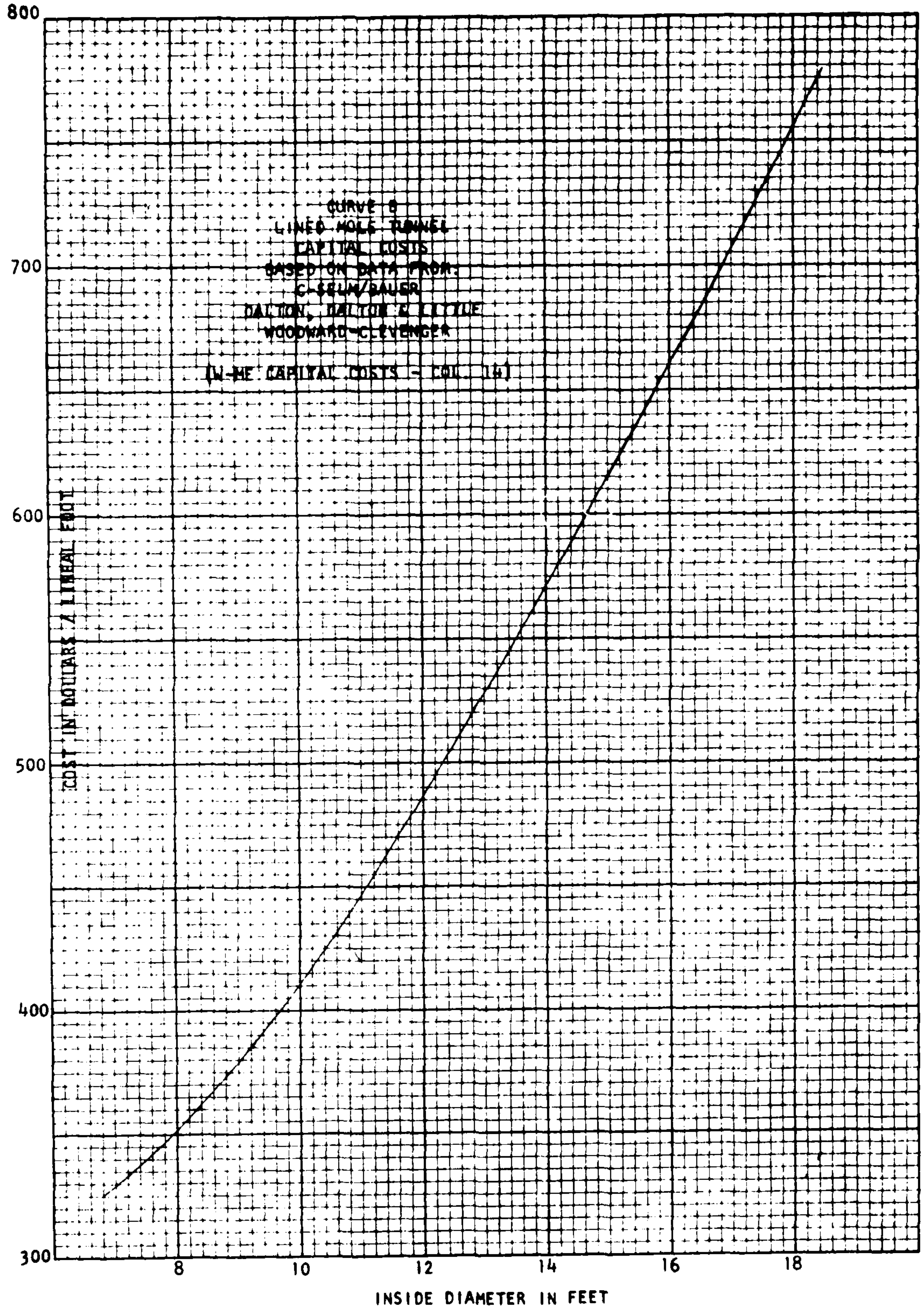
Wright-McLaughlin Engineers
Bauer Engineering

FINAL UNIT COST USED: 5 percent of Irrigation & Drainage Cost (Cols. 23 thru 27)

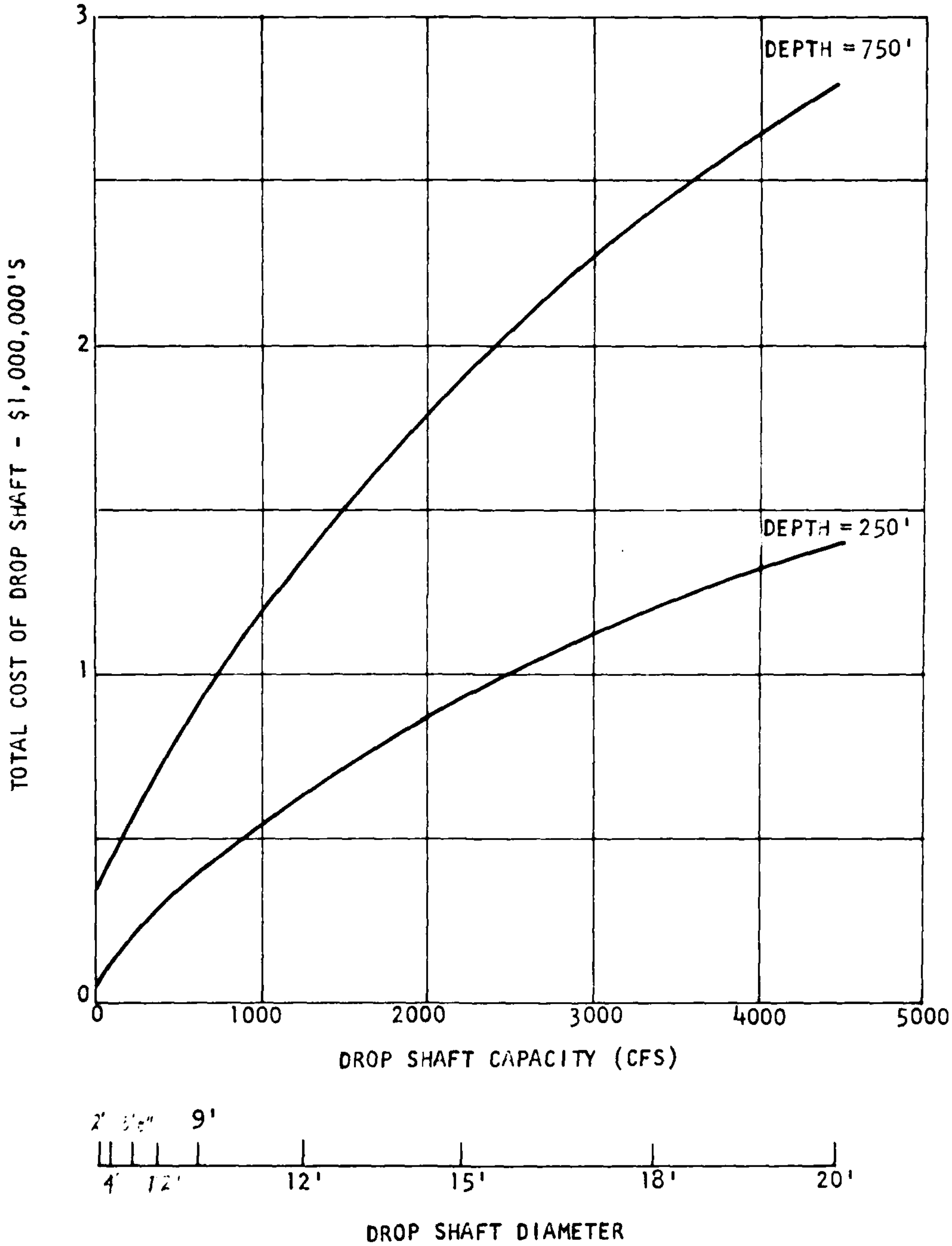

K-E LOGARITHMIC 46 7323
KEUFFEL & ESSER CO.
CURVE A
OCE COST CURVE (FIGURE 2[-33)
C-SELM/BAUER - FEB. 1972
CONSTRUCTION COSTS CONVERTED FROM OCE CURVE ($1,000/MGD) to $
(W-HE CAPITAL COSTS - COLUMNS 13 & 15)
PUMPING STATION - CAPITAL COSTS
FOR: SANITARY SEWAGE (UNTREATED)
(100' HEAD OR LESS)
FOR HEADS GREATER THAN 100 FEET
USE THE FORMULA:
$C = 1 + 0.25 \left(\frac{H-100}{100}\right)$ WHERE C = CONSTRUCTION COST
H = HEAD IN FEET
FOR PLANTS UNDER 1 MGD
.2 .3 .4 .5 .6 .7 .8 .9
100,000
90,000
80,000
70,000
60,000
CONSTRUCTION COSTS IN DOLLARS
1,000,000
500,000
300,000
200,000
100,000
90,000
1 2 3 4 5 6 7 8 9 10 20 30 40 50 60 70 80 90 100 200 300 400 500 600 700 800 900 1000
PUMPING PLANT IN MGD

CURVE A

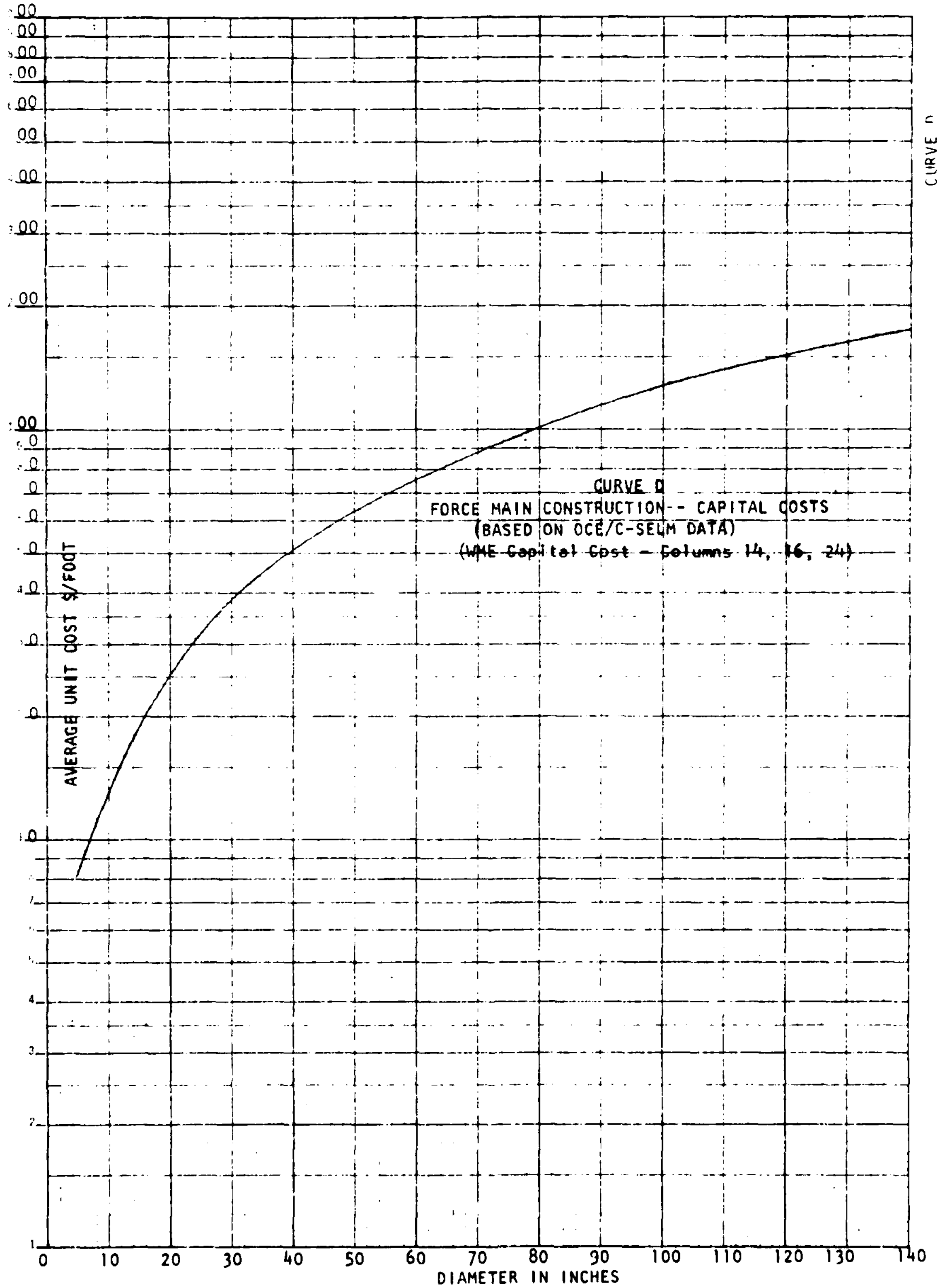
CURVE B


CURVE B
LINED HOLE TUNNEL
CAPITAL COSTS
BASED ON DATA FROM:
C-SELM/BAUER
DALTON, DALTON & LITTLE
WOODWARD-CLEVENGER
(W-ME CAPITAL COSTS - COL. 14)
COST IN DOLLARS / LINEAL FOOT
800
700
600
500
400
300
8
10
12
14
16
18
INSIDE DIAMETER IN FEET

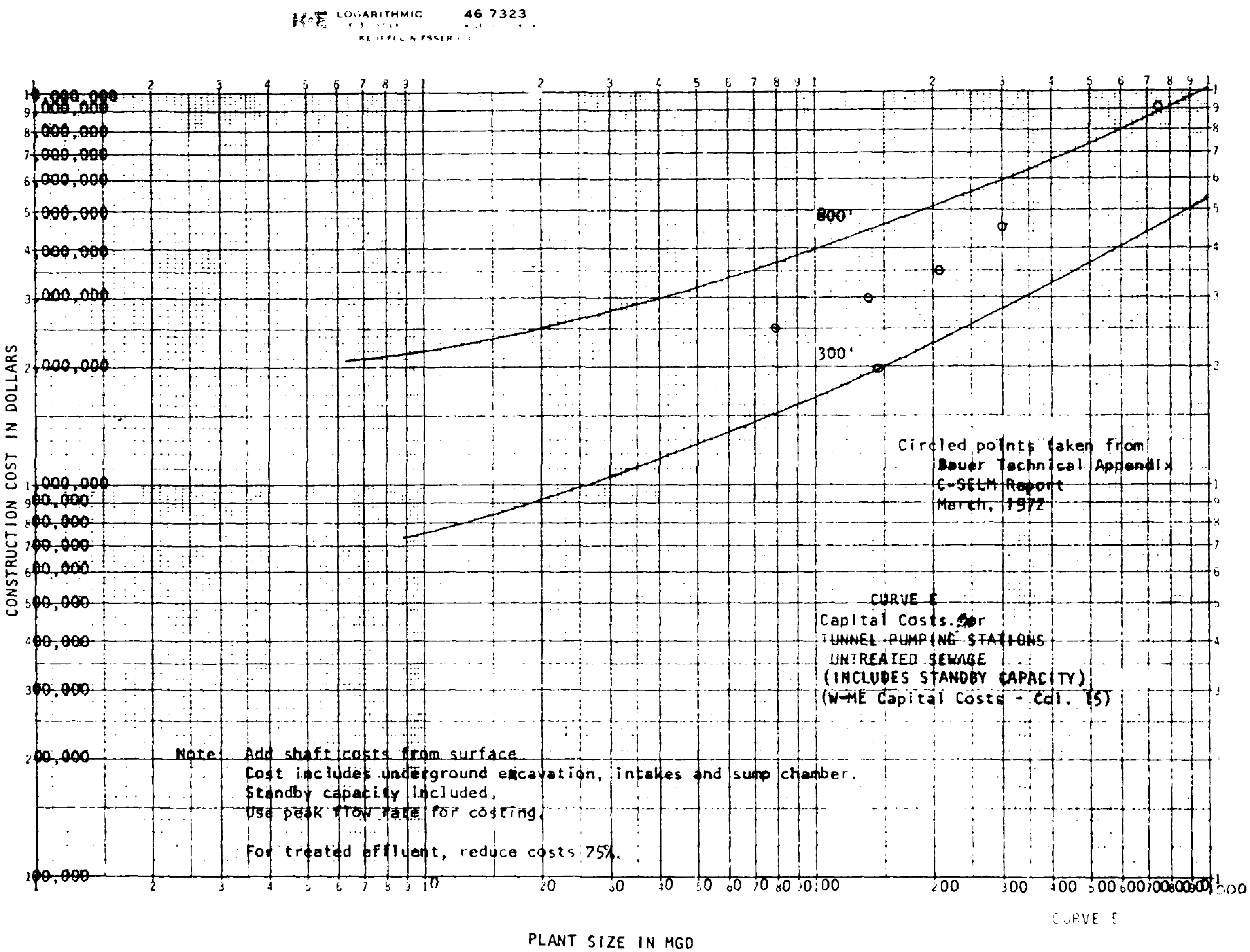
CURVE C
OCE, FIGURE 21-14
C-SELM, BAUER
(WME CAPITAL COSTS - COLS. 14 & 15)



CURVE C

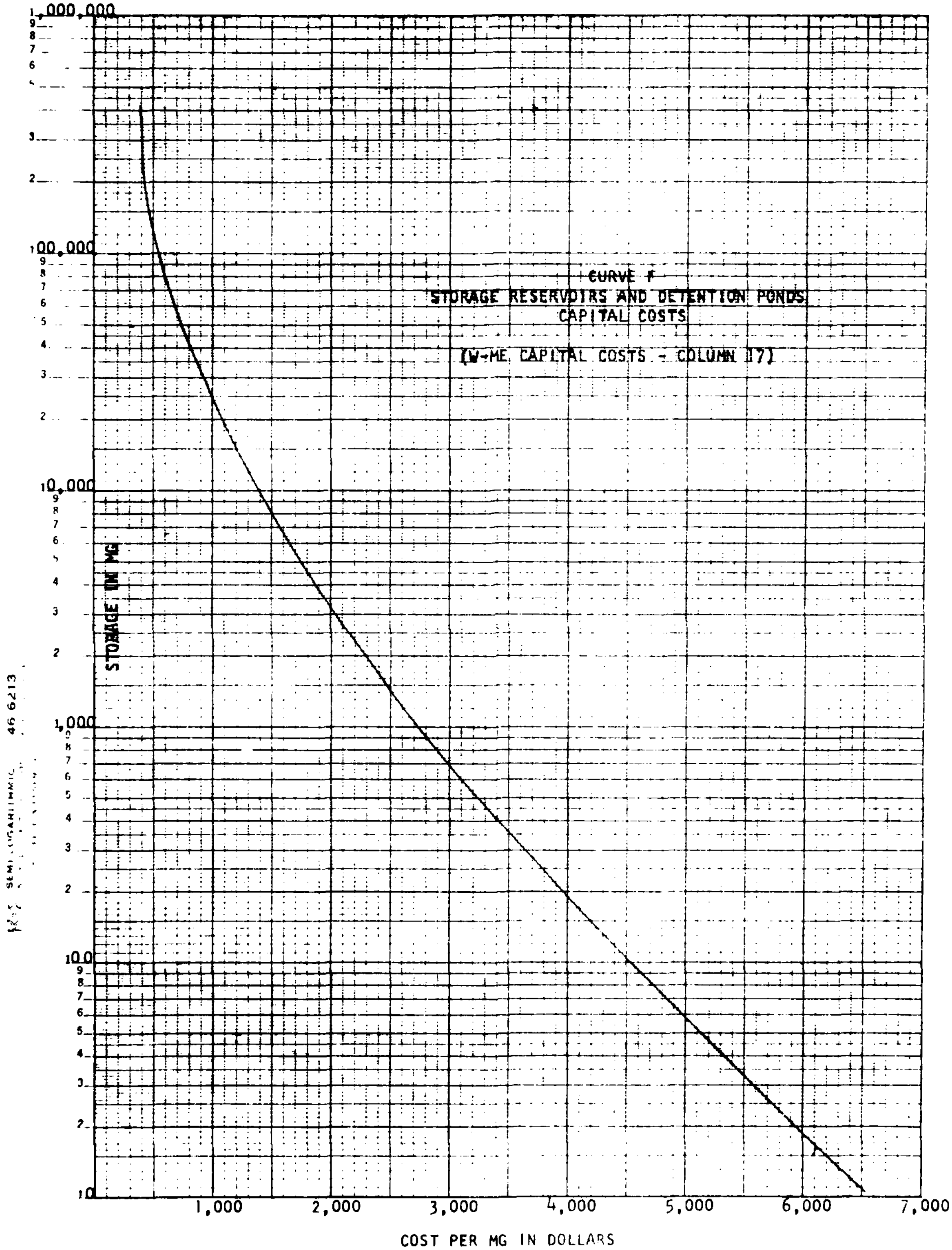


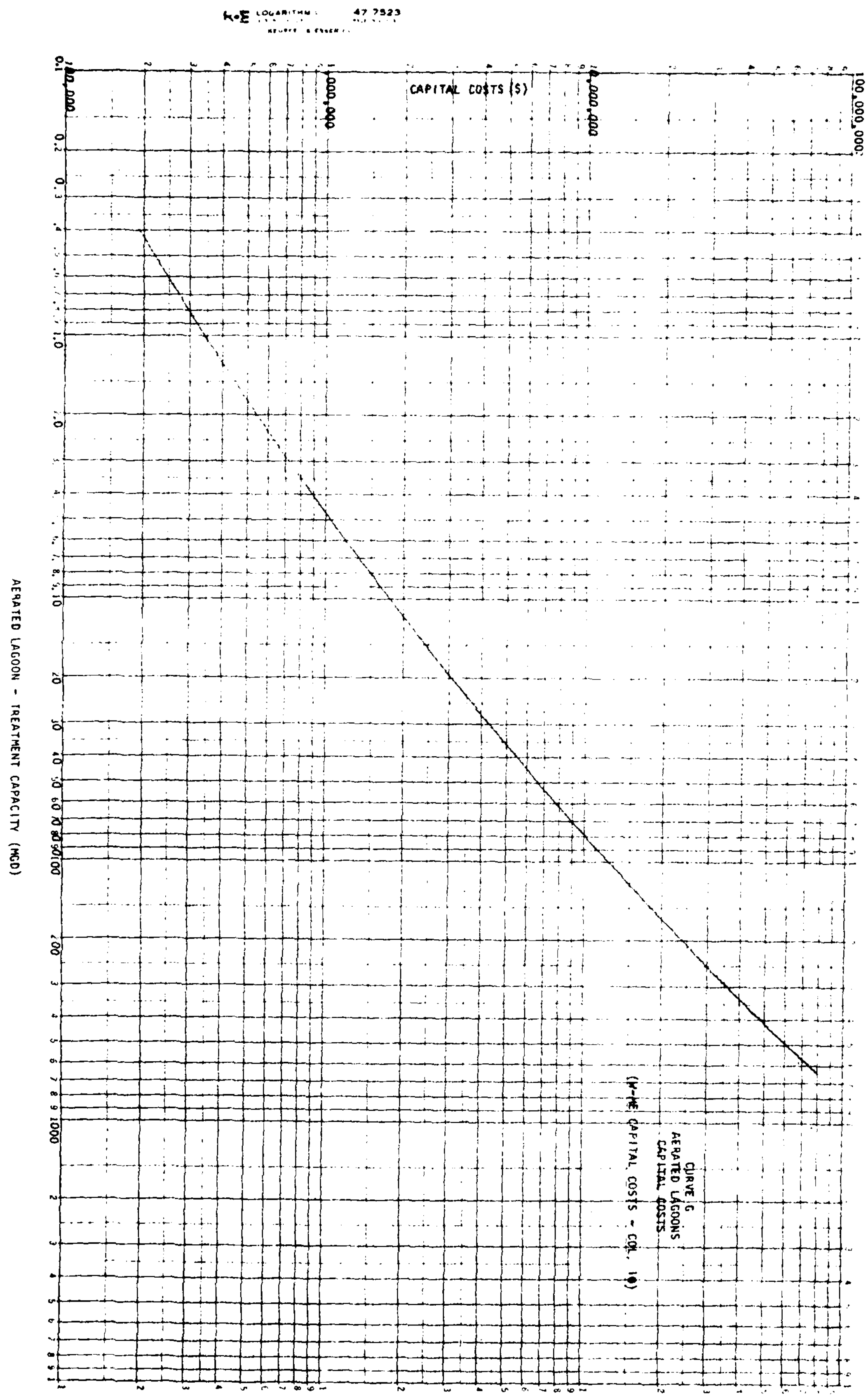
CURVE D
FORCE MAIN CONSTRUCTION -- CAPITAL COSTS
(BASED ON OCE/C-SELM DATA)
~~(WME Capital Cost - Columns 14, 16, 24)~~
AVERAGE UNIT COST $/FOOT
DIAMETER IN INCHES
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
CURVE D



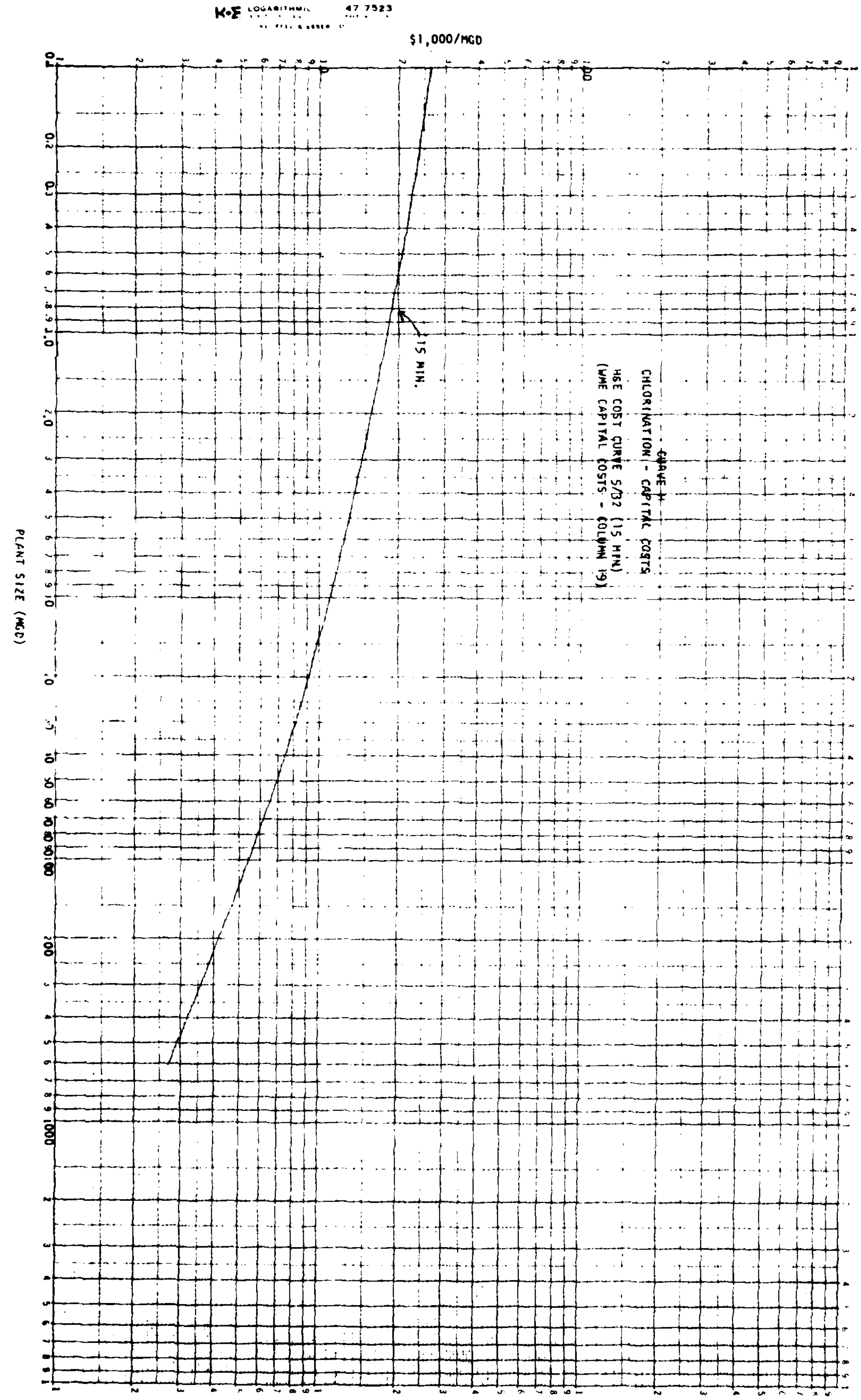
CONSTRUCTION COST IN DOLLARS
PLANT SIZE IN MGD
800'
300'
Circled points taken from
Bauer Technical Appendix
C-SELM Report
March, 1972
CURVE E
Capital Costs for
TUNNEL PUMPING STATIONS
UNTREATED SEWAGE
(INCLUDES STANDBY CAPACITY)
(W-ME Capital Costs - Col. 15)
Note: Add shaft costs from surface.
Cost includes underground excavation, intakes and sump chamber.
Standby capacity included.
Use peak flow rate for costing.
For treated effluent, reduce costs 25%.

CURVE E

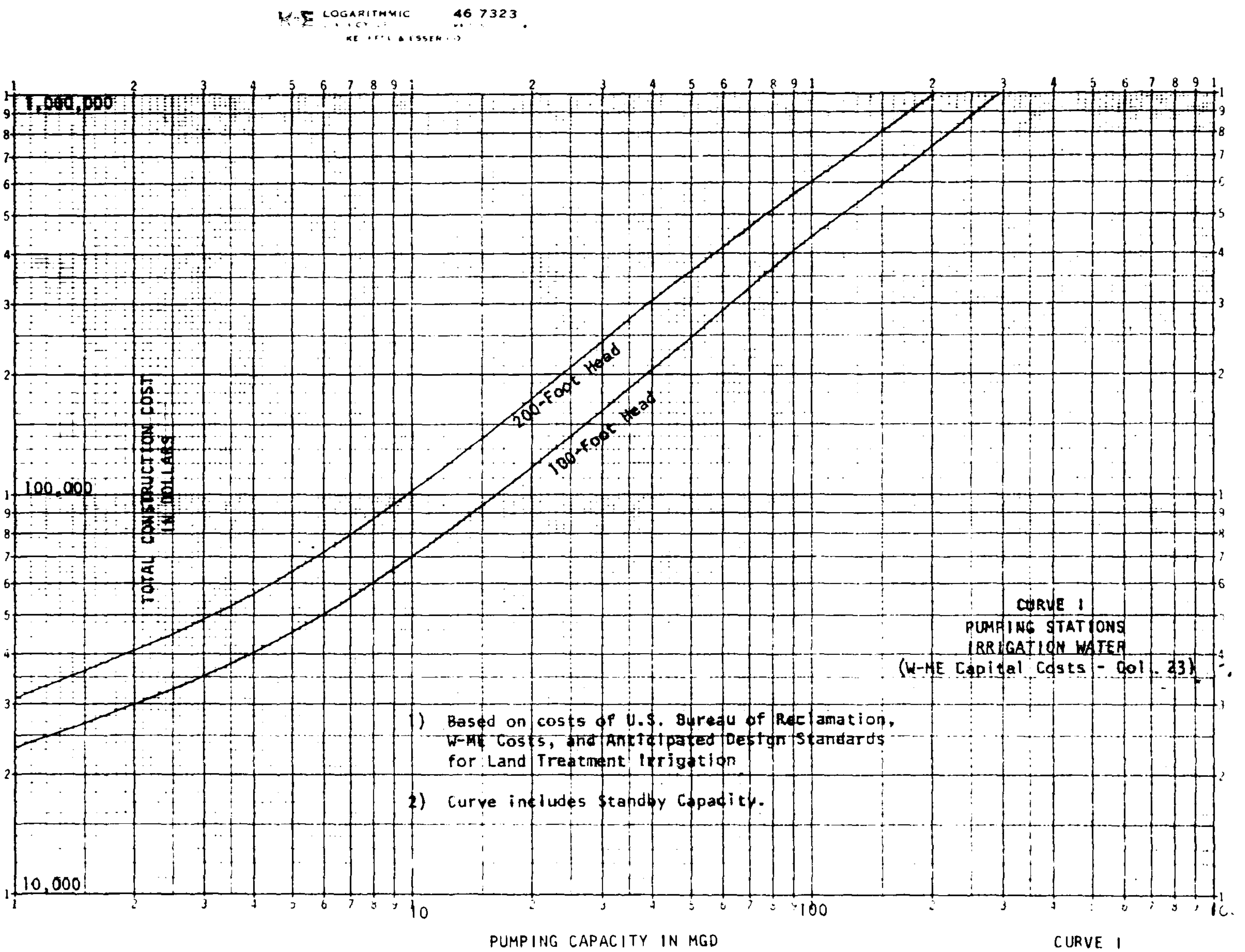

CURVE F
STORAGE RESERVOIRS AND DETENTION PONDS
CAPITAL COSTS
(W-ME CAPITAL COSTS - COLUMN 17)
STORAGE IN MG
COST PER MG IN DOLLARS
1,000,000
100,000
10,000
1,000
100
10
1,000
2,000
3,000
4,000
5,000
6,000
7,000
46 6213


K+E LOGARITHMIC 47 7523
CAPITAL COSTS ($)
100,000
1,000,000
10,000,000
100,000,000
AERATED LAGOON - TREATMENT CAPACITY (MGD)
CURVE G
AERATED LAGOONS
CAPITAL COSTS
(K-ME CAPITAL COSTS - COL. 10)

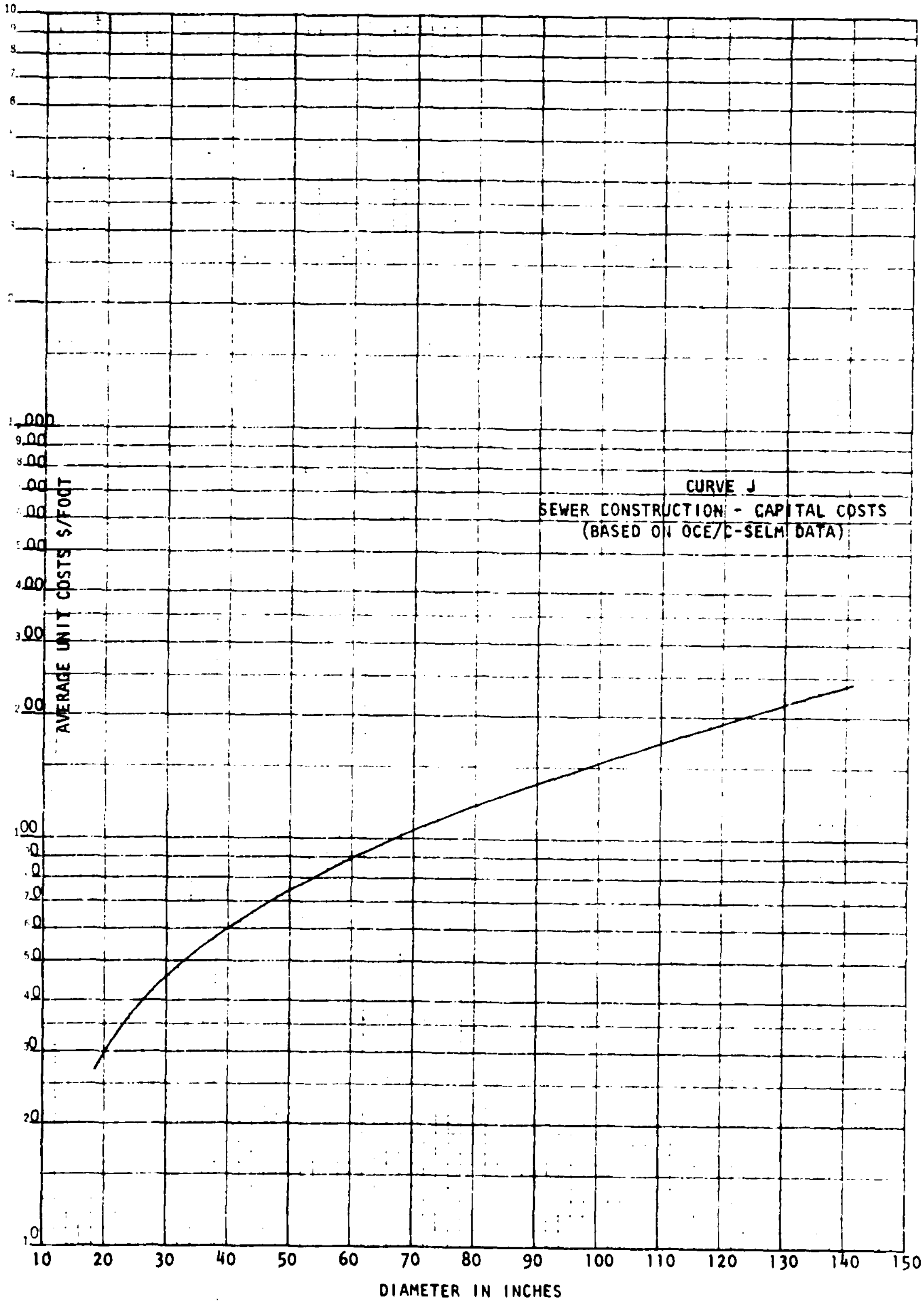
CURVE G


K+E LOGARITHMIC 47 7523
$1,000/MGD
CURVE H
CHLORINATION - CAPITAL COSTS
H&E COST CURVE 5/32 (15 MIN)
(WME CAPITAL COSTS - COLUMN 19)
15 MIN.
PLANT SIZE (MGD)

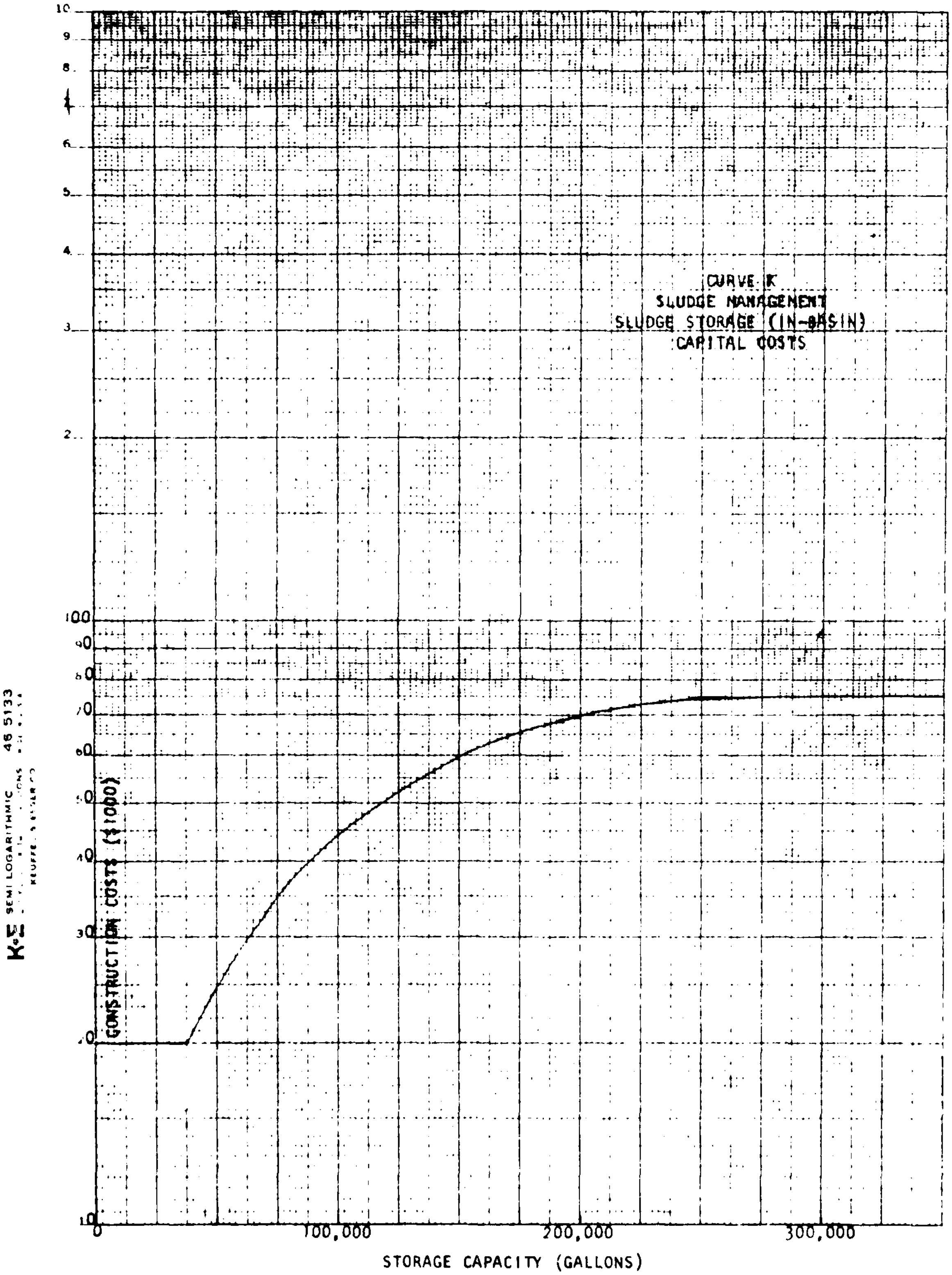
CURVE H


K-E LOGARITHMIC 46 7323
1,000,000
100,000
10,000
TOTAL CONSTRUCTION COST IN DOLLARS
200-Foot Head
100-Foot Head
CURVE I
PUMPING STATIONS
IRRIGATION WATER
(W-ME Capital Costs - Col. 23)
1) Based on costs of U.S. Bureau of Reclamation, W-ME Costs, and Anticipated Design Standards for Land Treatment Irrigation
2) Curve includes Standby Capacity.
10
100
PUMPING CAPACITY IN MGD

CURVE I

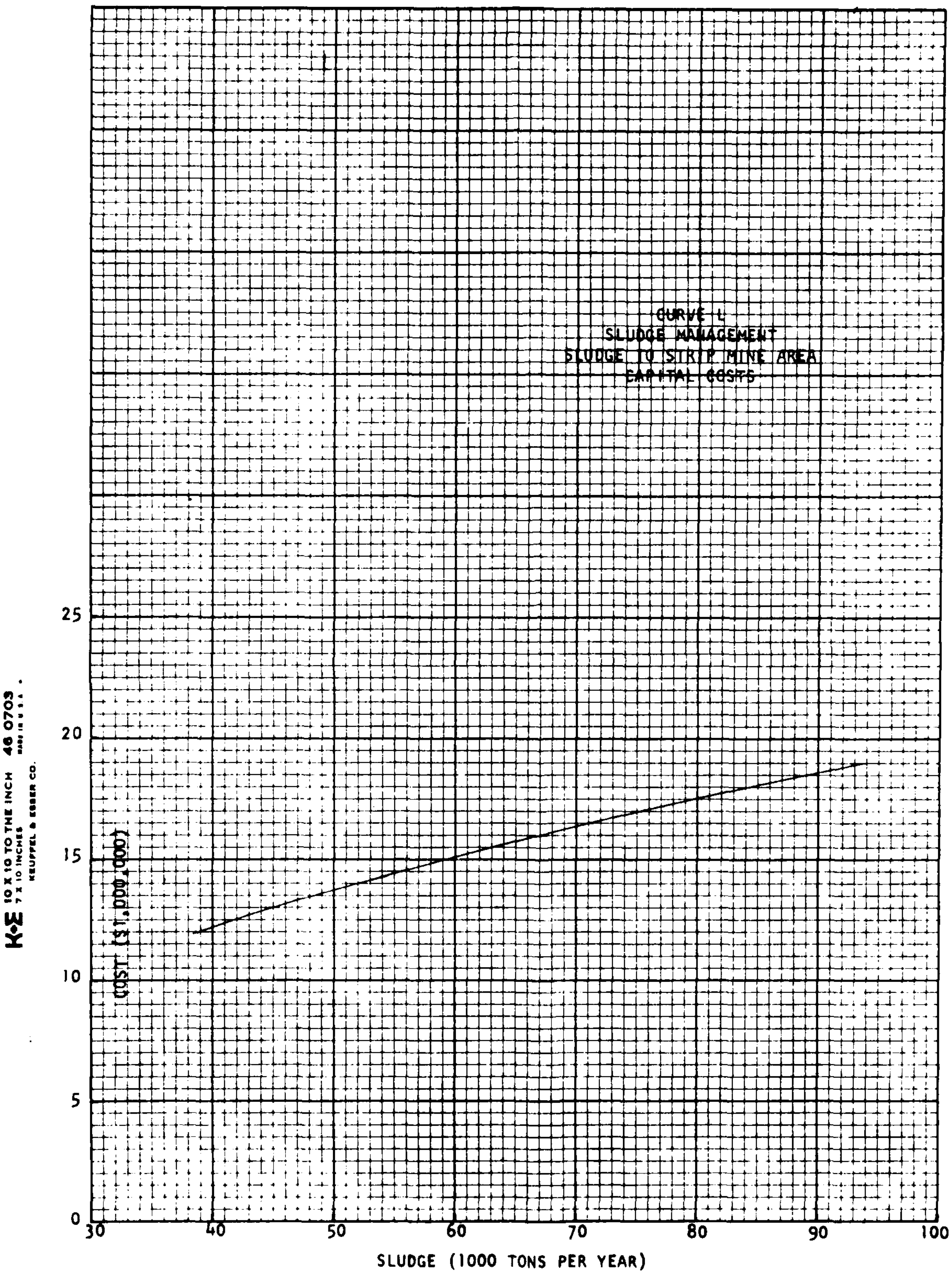

CURVE J
SEWER CONSTRUCTION - CAPITAL COSTS
(BASED ON OCE/C-SELM DATA)
AVERAGE UNIT COSTS $/FOOT
1,000
200
100
10
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
DIAMETER IN INCHES

CURVE K



CURVE K
SLUDGE MANAGEMENT
SLUDGE STORAGE (IN-BASIN)
CAPITAL COSTS
CONSTRUCTION COSTS ($1000)
STORAGE CAPACITY (GALLONS)
0
100,000
200,000
300,000
10
20
30
40
50
60
70
80
90
100
K-E SEMI-LOGARITHMIC 46 5133

CURVE L



CURVE L
SLUDGE MANAGEMENT
SLUDGE TO STRIP MINE AREA
CAPITAL COSTS
COST ($1,000,000)
0
5
10
15
20
25
30
40
50
60
70
80
90
100
SLUDGE (1000 TONS PER YEAR)
K+E 10 X 10 TO THE INCH 46 0703
7 X 10 INCHES
KEUFFEL & ESSER CO.

OPERATION & MAINTENANCE COSTS

Land Treatment/Formulation Phase 2 Sub - Item

UNIT COST CONTAINED IN DETAILED COSTING SHEETS SHEET NO. 1 OF 1
FOR COLUMN #: 1-6 JOB NO. 712-70
ITEM: Basic Data BY GGR DATE 9-20-72

A. Cost Type: Capital Cost______ Operation & Maintenance (O&M) X

B. General Component Heading:

Transmission Facilities______ Irrigation System______
Storage Reservoirs______ Drainage______
Land Treatment Site______ Miscellaneous______

C. Cost Item: Basic Data (Used in Costing) Column: 1-6
Name

The basic data shown in columns 1-6, as well as the costs compiled under the Capital Costs Section contained herein, were used to determine the various Operation and Maintenance unit costs which follow in this O&M Costs Section.

(See Capital Cost Sheet covering columns 1-6 for explanation of individual column items.)

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase: 2   Sub - Item: ____

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 1 OF 1
FOR COLUMN #: 7-11   JOB NO. 712 - 70
ITEM: Treatment (In Plants or Aerated Lagoons)   BY GGR   DATE 9-20-72

A. Cost Type   Capital Cost ____   Operation & Maintenance (O&M) X
B. General Component Heading:
Treatment Facilities X   Irrigation System ____
Transmission Facilities ____   Drainage ____
Storage Reservoirs ____   Miscellaneous ____
Land Treatment Site ____

C. Cost Item: Treatment (In Plants or Aerated Lagoons)   Column: 7-11
Name

COMPUTATION:

All O&M costs for sewage treatment plants are supplied by Havens & Emerson except those for Aerated Lagoons. (See the computation sheets for Column 10 - Aerated Lagoons, which follow.)

Aerated Lagoons were used for 3 plants in Plan 9A and all plants in Plan 12.

EXPLANATION:

REFERENCES:

Havens & Emerson - Secondary, Tertiary and Advanced Wastewater Treatment Plant Costs
Wright-McLaughlin Engineers - Aerated Lagoon Costs

FINAL UNIT COST USED: All costs supplied by Havens and Emerson except as in Plans 9A & 12

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation Phase 2 Sub - Item ___

UNIT COST CONTAINED IN DETAILED COSTING SHEETS SHEET NO. 1 OF 3
FOR COLUMN #: 10A (Treatment) JOB NO. 72 - 70
ITEM: Aerated Lagoons - Power BY IAB DATE 9-20 72

A. Cost Type: Capital Cost ___ Operation & Maintenance (O&M) X
B. General Component heading:
Transmission Facilities ___ Irrigation System ___
Storage Reservoirs ___ Drainage ___
Land Treatment Site ___ Miscellaneous ___

C. Cost Item: Aerated Lagoons - Power (Name) Column: 10A

COMPUTATION:

For both IN-BASIN and OUT-OF-BASIN:

$7,550 x Total ADF (MGD)

Note: For Plan 9A, 3 plants which were costed individually have aerated lagoons; these costs were included in land treatment costs In Plan 12 all plants were costed with aerated lagoons

EXPLANATION:

Power costs for aeration include mixing and oxygen transfer. W-ME computed detailed horsepower requirements

REFERENCES:

Wright-McLaughlin Engineers

FINAL UNIT COST USED: $7,550 x Total ADF (MGD)

NOTE: For Plans 9A and 12 only.

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/~~Formulation~~ Phase 2 Sub - Item: ____

UNIT COST CONTAINED IN DETAILED COSTING SHEETS — SHEET NO. 2 OF 3
FOR COLUMN #: 10B (Treatment) — JOB NO. 712-70
ITEM: Aerated Lagoons - Maintenance and Labor — BY HAB DATE 9-20-72

A. Cost Type: Capital Cost ____ Operation & Maintenance (O&M) X
B. General Component Heading:
Transmission Facilities ____ Irrigation System ____
Storage Reservoirs ____ Drainage ____
Land Treatment Site ____ Miscellaneous ____

C. Cost Item: Aerated Lagoons - Maint. & Labor (Name) Column: 10B

COMPUTATION:

3% of Capital Cost

Note: For Plan 9A, 3 plants which were costed individually have aerated lagoons; these costs were included in land treatment costs. In Plan 12 all plants were costed with aerated lagoons.

EXPLANATION:

Typical maintenance and labor figures based on W-ME experience were also used for comparison.

REFERENCES:

Wright-McLaughlin Engineers

FINAL UNIT COST USED: 3% of Capital Cost
NOTE: For Plans 9A and 12 only.

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation Phase: 2 Sub - Item:

UNIT COST CONTAINED IN DETAILED COSTING SHEETS SHEET NO. 3 OF 3
FOR COLUMN #: 10C (Treatment) JOB NO. 712 - 70
ITEM: Chlorination - Aerated Lagoons - Maint. & Labor (Power Negligible) BY HAB DATE 9-20-72

A. Cost Type: Capital Cost ___ Operation & Maintenance (O&M) X
B. General Component Heading:
Transmission Facilities ___ Irrigation System ___
Storage Reservoirs ___ Drainage ___
Land Treatment Site ___ Miscellaneous ___

C. Cost Item: Chlorination - Aerated Lagoons Column: 10C
Name

COMPUTATION:

In-Basin $3,650 x Total ADF (MGD)

Out-of-Basin $2,500 x Total ADF (MGD)

Note: For Plan 9A, 3 plants which were costed individually have aerated lagoons; these costs were included in land treatment costs. In Plan 12 all plants were costed with aerated lagoons.

EXPLANATION:

OCE and H&E curves for O&M were used to arrive at these two conversions. The Out-of-Basin unit costs are less because larger systems are used.

REFERENCES:
Havens and Emerson
OCE

FINAL UNIT COST USED: $3,650 x Total ADF (MGD), In-Basin

$2,500 x Total ADF (MGD), Out-of-Basin

NOTE: For Plans 9A and 12 only.

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase: 2   Sub - Item: ____

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 1 OF 2
FOR COLUMN #: 13A   JOB NO. 712-70
ITEM: Pump Station -- Power   BY HAB   DATE 9-21-72

A. Cost Type: Capital Cost ____   Operation & Maintenance (O&M) X
B. General Component Heading:
Transmission Facilities X   Irrigation System ____
Storage Reservoirs ____   Drainage ____
Land Treatment Site ____   Miscellaneous ____

C. Cost Item: Pump Station -- Power (Name)   Column: 13A

COMPUTATION:

No In-Basin facilities

Out-of-Basin = $2,100 x Total ADF (MGD)

EXPLANATION:

Cost is based upon TDH of 100'.

Basic data ($.0121/kwhr and 65% wire to water efficiency used to provide costs consistent and comparable to costs provided by H&E.)

As a check, the maintenance and labor was added to the power and compared to annual O&M costs for pumping stations as provided by H&E. The total W-ME O&M costs were also checked against OCE curves.

REFERENCES:

$.0121/kwhr and 65% wire to water efficiency -- Havens & Emerson
Curve for Annual Power Costs by Wright-McLaughlin Engineers
ADF - computed by W-ME and H&E
TDH - W-ME computations for individual plans

FINAL UNIT COST USED: $2,100 x total ADF (MGD)

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation Phase: 2 Sub - Item: ______

UNIT COST CONTAINED IN DETAILED COSTING SHEETS SHEET NO. 2 OF 2
FOR COLUMN #: 13B JOB NO. 712-70
ITEM: PUMP STATION - MAINTENANCE AND LABOR BY HAB DATE 9/21/72

A. Cost Type: Capital Cost ____ Operation & Maintenance (O&M) X
B. General Component Heading:
Transmission Facilities X Irrigation System ____
Storage Reservoirs ____ Drainage ____
Land Treatment Site ____ Miscellaneous ____
C. Cost Item MAINTENANCE AND LABOR EXCLUDING POWER (Name) Column: 13B

COMPUTATION: FOR OUT-OF-BASIN PUMP STATIONS . . . . . . 5% of Capital Cost

EXPLANATION: For annual maintenance and labor costs of pump stations, excluding power, 5% of the capital cost was used. This was obtained from expenses for given sized plants in Colorado based on past experience. As a check, maintenance and labor costs were added to power costs and compared to annual total O&M costs for pumping stations as defined by Havens and Emerson.

REFERENCES: See Sheet 1 of 2.

FINAL UNIT COST USED: 5 Percent of Capital Cost

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase: 2   Sub - Item:

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 1 OF 1
FOR COLUMN #: 14, 16 and 24   JOB NO. 712-70
ITEM: Force Main, Drop Shaft, Tunnel - Maintenance & Labor   BY HAB   DATE 8-20-72

A. Cost Type: Capital Cost ____   Operation & Maintenance (O&M) X
B. General Component Heading:
Transmission Facilities X   Irrigation System X
Storage Reservoirs ____   Drainage ____
Land Treatment Site ____   Miscellaneous ____

C. Cost Item: Force Main, Drop Shaft, Tunnel (Name)   Column: 14, 16 and 24

COMPUTATION:

1/2% of Capital Cost

EXPLANATION:

The 1/2% rate was obtained from Havens & Emerson. This percentage was used for force mains, drop shafts, and tunnel costs in order to provide costs consistent and comparable to costs by Havens & Emerson.

REFERENCES:

Havens & Emerson

FINAL UNIT COST USED: 1/2% of Capital Cost

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase: 2   Sub - Item:

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 1 OF 2
FOR COLUMN #: 15A   JOB NO. 712-70
ITEM: Secondary Pump Plant - Power   BY HAB   DATE 9-21-72

A. Cost Type: Capital Cost ____   Operation & Maintenance (O&M) X
B. General Component Heading:
Transmission Facilities X   Irrigation System ____
Storage Reservoirs ____   Drainage ____
Land Treatment Site ____   Miscellaneous ____

C. Cost Item: Secondary Pump Plant - Power (Name)   Column: 15A

COMPUTATION:

In-Basin = $5,550 x Total ADF (MGD)

Out-of-Basin = $15,000 x Total ADF (MGD)

EXPLANATION:

In-Basin TDH = 265'
Out-of-Basin TDH = 720'

Basic data ($.0121/kwhr and 65% wire to water efficiency) used to provide costs consistent and comparable to costs provided by H&E.

As a check, the maintenance and labor was added to the power and compared to annual O&M costs for pumping stations as provided by H&E. The total W-ME O&M costs were also checked against OCE curves.

REFERENCES:

$.0121/kwhr and 65% wire to water efficiency -- Havens & Emerson
Curve for Annual Power Costs by Wright-McLaughlin Engineers
ADF - computed by Wright-McLaughlin Engineers and Havens & Emerson
TDH - Wright-McLaughlin Engineers computations for individual plans

FINAL UNIT COST USED: $5,550 x Total ADF (MGD), In-Basin
$15,000 x Total ADF (MGD), Out-of-Basin

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation — Phase: 2 — Sub - Item: ____

UNIT COST CONTAINED IN DETAILED COSTING SHEETS — SHEET NO. 2 OF 2
FOR COLUMN #: 15B — JOB NO. 712-70
ITEM: Secondary Pump Plant - Maintenance and Labor — BY HAB DATE 9-21-72

A. Cost Type: Capital Cost ____ Operation & Maintenance (O&M) X
B. General Component Heading:
Transmission Facilities X — Irrigation System ____
Storage Reservoirs ____ — Drainage ____
Land Treatment Site ____ — Miscellaneous ____

C. Cost Item: Secondary Pump Plant - Maint. & Labor (Name) — Column: 15B

COMPUTATION:

For In-Basin Pump Stations . . . . . . 5% of Capital Cost

For Out-of-Basin Pump Stations . . . . 3% of Capital Cost

EXPLANATION:

For annual maintenance and labor costs of pump stations, excluding power, 5% of the capital cost was used for in-basin stations and 3% of the capital cost for stations out-of-basin. This was obtained from expenses for given sized plants in Colorado based on past experience. As a check, maintenance and labor costs were added to power costs and compared to total annual O&M costs for pumping stations as defined by Havens and Emerson. Out-of-Basin costs are less because the pump station capital costs included shafts and other related items which would have an O&M of approximately 1/2% x capital.

REFERENCES:

See Sheet 1 of 2.

FINAL UNIT COST USED: 5% of Capital Cost, In-Basin
3% of Capital Cost, Out-of-Basin

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase: 2   Sub - Item: ______

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 1 OF 1
FOR COLUMN #: 17   JOB NO. 712-70
ITEM: Reservoir - Maintenance & Labor   BY HAB   DATE 9-20-72

A. Cost Type: Capital Cost ______   Operation & Maintenance (O&M) X
B. General Component Heading:
Transmission Facilities ______   Irrigation System ______
Storage Reservoirs X   Drainage ______
Land Treatment Site ______   Miscellaneous ______

C. Cost Item: Reservoir - Maintenance & Labor (Name)   Column: 17

COMPUTATION:

1/2% of Capital Cost

EXPLANATION:

Based on O&M cost for force mains and shafts plus general experience with similar type reservoirs.

REFERENCES:

Wright-McLaughlin Engineers

FINAL UNIT COST USED: 1/2% of Capital Cost

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase: 2   Sub - Item: ____

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 1 OF 1
FOR COLUMN #: 18A - Power; 18B - Maintenance & Labor   JOB NO. 712-70
ITEM: Aeration   BY HAB   DATE 9-21-72

A. Cost Type: Capital Cost ____   Operation & Maintenance (O&M) X
B. General Component Heading:
Transmission Facilities ____   Irrigation System ____
Storage Reservoirs X   Drainage ____
Land Treatment Site ____   Miscellaneous ____

C. Cost Item: Aeration - Power/Maint.& Labor   Column: 18A and 18B
Name

COMPUTATION:

For Plans 9A and 12
In-Basin
Power = $20 x Storage Reservoir Volume in MG

Maintenance and Labor:

$20 x Storage Reservoir Volume in MG

Out-of-Basin and in reservoirs for stormwater runoff in-basin there is no aeration of storage reservoirs.

EXPLANATION:

In-Basin, Plans 9A and 12 -- Power was determined by W-ME.

REFERENCES:

Wright-McLaughlin Engineers

FINAL UNIT COST USED: $20 x Storage Reservoir Volume in MG for Power and
$20 x Storage Reservoir Volume in MG for Maintenance & Labor

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase: 2   Sub - Item: ____

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 1 OF 1
FOR COLUMN #: 19B   JOB NO. 712 - 70
ITEM: Chlorination - Maint. & Labor (Assumes Power Cost Negligible)   BY HAB   DATE 9-21-72

A. Cost Type: Capital Cost ____   Operation & Maintenance (O&M) X
B. General Component Heading:
Transmission Facilities ____   Irrigation System ____
Storage Reservoirs X   Drainage ____
Land Treatment Site ____   Miscellaneous ____

C. Cost Item: Chlorination (Name)   Column: 19B

COMPUTATION:

Effluent to storage reservoirs to land site treatment:

$1,825 x Total ADF (MGD)

EXPLANATION:

This is 1/2 of the H&E and OCE chlorination O&M costs as the chlorine treatment concentration is less than 1/2 required for secondary treated sewage. This cost is equivalent to that used by Bauer Engineering.

REFERENCES:

OCE
Bauer Engineering

FINAL UNIT COST USED: $1,825 x Total ADF (MGD)

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation Phase: 2 Sub - Item:

UNIT COST CONTAINED IN DETAILED COSTING SHEETS SHEET NO. 1 OF 1
FOR COLUMN #: 20 and 22 (Col. 21 Cost was dropped) JOB NO. 712-70
ITEM: Purchase & Relocation; Site Preparation BY W-ME DATE 9-22-72

A. Cost Type: Capital Cost ____ Operation & Maintenance (O&M) X
B. General Component Heading:
Transmission Facilities ____ Irrigation System ____
Storage Reservoirs ____ Drainage ____
Land Treatment Site X Miscellaneous ____

C. Cost Item: Purchase & Relocation; Site Prep. Column: 20 and 22
Name

THERE ARE NO OPERATION AND MAINTENANCE COSTS FOR THE FOLLOWING:

Component	Column
Land Treatment Site	
Purchase and Relocation	20
Site Preparation	22

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase: 2   Sub - Item:

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 1 OF 2
FOR COLUMN #: 23A   JOB NO. 712 - 70
ITEM: Pump Station - Power   BY HAB   DATE 9-21-72

A. Cost Type: Capital Cost ____ Operation & Maintenance (O&M) X
B. General Component Heading:
Transmission Facilities ____ Irrigation System X
Storage Reservoirs ____ Drainage ____
Land Treatment Site ____ Miscellaneous ____

C. Cost Item: Pump Station - Power (Name)   Column: 23A

COMPUTATION:

In-Basin = Wastewater: $18 x acres
Separate Stormwater: $36 x acres

Out-of-Basin = $16 x acres

EXPLANATION: In-Basin
Wastewater - TDH = 150'
Average application rate = 75"
Stormwater - TDH = 150'
Average application rate = 150"
Out-of-Basin
TDH = 150'
Average application rate = 66"

Basic data ($.0121/kwhr and 65% wire to water efficiency) used to provide costs consistent and comparable to costs provided by H&E. The total W-ME O&M costs were also checked against OCE curves.

REFERENCES:

$.0121/kwhr and 65% wire to water efficiency - Havens & Emerson
ADF computed by Wright-McLaughlin Engineers and Havens & Emerson
TDH - Wright-McLaughlin Engineers computations for individual plans

FINAL UNIT COST USED: In-Basin Wastewater - $18 x acres
In-Basin Separate Stormwater - $36 x acres
Out-of-Basin - $16 x acres

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation — Phase: 2 — Sub - Item: ____

UNIT COST CONTAINED IN DETAILED COSTING SHEETS — SHEET NO. 2 OF 2
FOR COLUMN #: 23B — JOB NO. 712-70
ITEM: Pump Station - Maintenance and Labor — BY W-ME — DATE 9-21-72

A. Cost Type: Capital Cost ____ Operation & Maintenance (O&M) X
B. General Component Heading:
Transmission Facilities ____ Irrigation System X
Storage Reservoirs ____ Drainage ____
Land Treatment Site ____ Miscellaneous ____

C. Cost Item: Pump Station - Maintenance & Labor (Name) — Column: 23B

COMPUTATION:

For In-Basin Pump Stations . . . . . 5% of Capital Cost

For Out-of-Basin Pump Stations . . . 3% of Capital Cost

EXPLANATION:

For annual maintenance and labor costs of pump stations, excluding power, 5% of the capital cost was used for in-basin stations and 3% of the capital cost for stations out-of-basin. This was obtained from expenses for given sized plants in Colorado based on past experience. As a check, maintenance and labor costs were added to power costs and compared to total annual O&M costs for pumping stations as defined by Havens and Emerson.

REFERENCES:

See Sheet 1 of 2.

FINAL UNIT COST USED: 5% of Capital Cost In-Basin
3% of Capital Cost Out-of-Basin

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation — Phase 2 — Sub - Item

UNIT COST CONTAINED IN DETAILED COSTING SHEETS — SHEET NO. 1 OF 1
FOR COLUMN #: 25 — JOB NO. 712 - 70
ITEM: Equipment and Distribution Piping - Maint. & Labor — BY HAB — DATE 9-21-72

A. Cost Type: Capital Cost ____ Operation & Maintenance (O&M) X
B. General Component Heading:
Transmission Facilities ____ Irrigation System X
Storage Reservoirs ____ Drainage ____
Land Treatment Site ____ Miscellaneous ____

C. Cost Item: Equipment and Distribution Piping (Name) — Column: 25

COMPUTATION:

In-Basin = $4/acre

Out-of-Basin = $10/acre

EXPLANATION:

Mini-border system used in-basin and some solid set system. Both would have same maintenance and labor costs. The $10 rate reflects an increase due to higher labor and maintenance on pivot sprinklers.

REFERENCES:

Donald L. Miles - Agricultural Extension Agent for Colorado
Wright-McLaughlin Engineers

FINAL UNIT COST USED: $4/acre In-Basin
$10/acre Out-of-Basin

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation Phase: 2 Sub - Item: ______

UNIT COST CONTAINED IN DETAILED COSTING SHEETS SHEET NO. 1 OF 1
FOR COLUMN #: 26 JOB NO. 712-70
ITEM: Tile - Maintenance and Labor BY HAB DATE 9-21-72

A. Cost Type: Capital Cost ____ Operation & Maintenance (O&M) X
B. General Component Heading:
Transmission Facilities ____ Irrigation System ____
Storage Reservoirs ____ Drainage X
Land Treatment Site ____ Miscellaneous ____

C. Cost Item: Tile - Maintenance and Labor Column: 26
Name

COMPUTATION:

In-Basin = $4/acre
Out-of-Basin = $4.50/acre

EXPLANATION:

Maintenance is approximately 1% of Capital Cost.

REFERENCES:

Donald L. Miles - Agricultural Extension Agent for Colorado
Wright-McLaughlin Engineers

FINAL UNIT COST USED: In-Basin - $4/acre
Out-of-Basin - $4.50/acre

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation　　　Phase: 2　Sub - Item: ____

UNIT COST CONTAINED IN DETAILED COSTING SHEETS　　SHEET NO. 1 OF 1
FOR COLUMN #: 27　　JOB NO. 712 - 70
ITEM: Conduits and Canals - Maintenance & Labor　　BY KBW DATE 9-16-72

A. Cost Type: Capital Cost ____　Operation & Maintenance (O&M) X
B. General Component Heading:
Transmission Facilities ____　Irrigation System ____
Storage Reservoirs ____　Drainage X
Land Treatment Site ____　Miscellaneous ____

C. Cost Item: Conduits and Canals　Column: 27
Name

COMPUTATION:

Cost of construction will be an average of $25/acre over and above drainage unit costs.

Maintenance and Labor cost for conduits and canals will be $2/acre.

EXPLANATION:

Conduits will be required to convey return flow to suitable discharge points. Canals will be used where volumes are large. Hydrological studies in western Ohio show stream regimes to be generally suitable. Based on evaluation of typical units and topographical maps, and on hydrological study of streams.

REFERENCES:

Wright-McLaughlin Engineers

FINAL UNIT COST USED: $2/acre
(Revision as of 9-14-72)

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase: 2   Sub - Item:

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 1 OF 1

FOR COLUMN #: 28   JOB NO. 712-70

ITEM: Sludge Management (Includes Power Cost)   BY HAB   DATE 9-21-72

A. Cost Type: Capital Cost ______ Operation & Maintenance (O&M) X

B. General Component Heading:
Transmission Facilities ______ Irrigation System ______
Storage Reservoirs ______ Drainage ______
Land Treatment Site ______ Miscellaneous ______

C. Cost Item: Sludge Management (Includes Power Cost) Name   Column: 28

COMPUTATION:

In-Basin
No O&M cost for separate stormwater derived sludge.
Plans 9A & 12 = $750 x Total ADF (MGD)
All other plans = $1200 x Total ADF (MGD)

Out-of-Basin
Plans 9A and 12 = $750 x Total ADF (MGD)
All other plans = $480 x Total ADF (MGD)

EXPLANATION:

The $750/MGD is equivalent to $25/ton for aerated lagoons. This was determined by W-ME based upon the required equipment and sludge disposal on land within approximately 6 miles.

The $480/MGD rate is equivalent to $16/ton which was obtained from the Bechtel Report on pipeline sludge disposal to strip mine areas.

The $1200/MGD is equivalent to $40/ton for In-Basin combined sludge disposal.

REFERENCES:

Wright-McLaughlin Engineers
Bechtel Corporation

FINAL UNIT COST USED: In-Basin - $1200 x Total ADF (MGD)
In-Basin Plans 9A and 12 - $750 x Total ADF (MGD)
Out-of-Basin - $480 x Total ADF (MGD)
Out-of-Basin Plans 9A and 12 - $750 x Total ADF (MGD)

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation　　Phase 2　Sub - Item:

UNIT COST CONTAINED IN DETAILED COSTING SHEETS　　SHEET NO. 1 OF 1
FOR COLUMN #: 29　　JOB NO. 712-70
ITEM: Miscellaneous - Maintenance & Labor　　BY KRW　DATE 9-16-72

A. Cost Type: Capital Cost ____　Operation & Maintenance (O&M) X
B. General Component Heading:
Transmission Facilities ____　Irrigation System ____
Storage Reservoirs ____　Drainage ____
Land Treatment Site ____　Miscellaneous X

C. Cost Item: Miscellaneous - Maint, & Labor　Column: 29
Name

COMPUTATION:

Compute O&M as 10% of capital cost of this item.

EXPLANATION:

Miscellaneous includes capital cost for administration building, monitoring holes for ground water, also outside electrical costs not already included in other major components and laboratories.

REFERENCES:

Wright-McLaughlin Engineers

FINAL UNIT COST USED: 10% of Capital Cost as computed for Miscellaneous in Column 29

CONTINGENCIES

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase 2   Sub - Item ____

UNIT COST CONTAINED IN DETAILED COSTING SHEETS ____ SHEET NO. 1 OF ____
FOR COLUMN #: ____ JOB NO. 712-70
ITEM: Contingency ____ BY KRW DATE 9-15-72

A. Cost Type: Capital Cost X Operation & Maintenance (O&M) ____
B. General Component Heading:
  Transmission Facilities ____ Irrigation System ____
  Storage Reservoirs ____ Drainage ____
  Land Treatment Site ____ Miscellaneous ____

C. Cost Item Contingency (Name) Column: ----

COMPUTATION:

1. A 20-percent contingency allowance will be added to the total cost estimate to allow for uncertainties.

2. An additional 5-percent will be added for engineering and design.

3. An additional 5-percent will be added for supervision and administration.

Total contingency added is 30 percent to capital costs.

EXPLANATION:

REFERENCES: Wastewater Management Program, "Study Procedure" by C.C.E dated Ma ., 1972.

FINAL UNIT COST USED: CAPITAL COSTS - 30%

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND - AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

Land Treatment/Formulation   Phase 2   Sub - Item

UNIT COST CONTAINED IN DETAILED COSTING SHEETS   SHEET NO. 1 OF 1

FOR COLUMN #: --   JOB NO. 71.2 10

ITEM: Contingency   BY KRW   DATE 9-6-72

A. Cost Type: Capital Cost ____ Operation & Maintenance (O&M) X

B. General Component Heading:

Transmission Facilities ____ Irrigation System ____
Storage Reservoirs ____ Drainage ____
Land Treatment Site ____ Miscellaneous ____

C. Cost Item Contingency (Name)   Column: --

COMPUTATION:

1. For O&M, a 20% contingency will be added for uncertainties and overhead/administration, and control operations. (No E&D or S&A added to O&M)

EXPLANATION:

REFERENCES: Wastewater Management Program, "Study Procedure," by OCE dated May 1, 1972

FINAL UNIT COST USED: O&M Costs - 20%

DET[illegible]LED [illegible] FOR [illegible]

FOR F[illegible]CILITIES RECEIVING: Municipal-Indu[illegible] [illegible]ined S.R.O./Muni[illegible]ipal S.[illegible] Treated S.R.O. ____
Sepa[illegible]ately [illegible] Only . . . . ____

PERCENT OF GRAND TOTAL [illegible] CAPITAL COSTS: Mu[illegible]ipal and Industrial . . . . . . ____
[illegible]ined and Sepa[illegible]ately [illegible] S.R.O. ____

All costs in $1,000

1	[illegible] DESIGN [illegible]					TREATMENT FACILITIES						TRANSMISSION FACILITIES			
1	[illegible]	[illegible]	[illegible]	5	6	7	[illegible]	[illegible]	10	11	12	[illegible]	14	15	[illegible]
[illegible]ME	Retention Storage MG	Plant Capacity (MGD)	Raw Sludge [illegible]	[illegible] Storage MG	Acres	Retention Storage	Sewers	[illegible]	Plant	Sludge	Total Columns 7-11	Pump [illegible]	Force Main Open Shaft Tunnel	Secondary Pump Plant	Force Main

E[illegible] COSTS FOR PLAN ____

[illegible] Municipal S.R. /Municipal S.P.P. Treated S.R.P. ____

All costs in $1,000

[illegible]	[illegible] LAND TREATMENT SITE						IRRIGATION SYSTEM			DRAINAGE SYSTEM			MISC	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	25	26	27	28	29	30
[illegible]	Res[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Site Preparation	Pump Station	Force Main	Equipment and Distribution Piping	Tile	Conduits and Canal	Sludge Management	Monitoring, Admin., Labs., Etc.	Total Columns 7-29

Sheet

$1,000

TRANSMISSION FACILITIES

14	15	16
Force Main Shaft Tunnel	Secondary Pump Plant	Force Main
14	15b	16
Maintenance Labor	Maint. & Labor	Maintenance Labor

DET[illegible]ILED OPERATI[illegible] AND M[illegible]INTEN[illegible]NCE COSTS FOR [illegible] ____

FOR F[illegible]CILITIES RECEI[illegible]ING: Muni[illegible]ipal-Indus[illegible] 1/Combined S.R.O./Muni[illegible] S.T. [illegible] Treated S.[illegible] ____
Separately Treat[illegible] S.R. [illegible] Or[illegible] . . . . ____

[illegible]ll Costs in $1,000

PL[illegible]	STORAGE RESERVOIR					LAND TREATMENT SITE			IRRIGATION SYSTEM				DRAINAGE SYSTEM				MISC.	
	17	18		19		20	21	22	23		24	25	26	27	28		29	30
	Reservoir	[illegible]eration		Chlorination		Purchase and Relocation		Site Preparation	Pump Station		Force Main	Equipment Distribution Piping	Tile	Conduits & Canals	Sludge Management		Monitoring, [illegible] Lab., Elec.	Total Columns 7-19
	17	[illegible]	18	19	19				[illegible]	23					[illegible]	[illegible]		
	Maintenance Labor	[illegible]	Maint. Labor	Power	Maint. Labor	[illegible] M		[illegible]	[illegible]	Maint. Labor	Maintenance Labor	Maint. Labor	Maintenance Labor	Maint. & Labor	Power	Maint. Labor	Maint. & Labor	

(SAME FORM FOR A, B)

COMPARABLE ANNUAL COST INDEX — YEAR 2020
COST IN $ 1000

[illegible] PLAN
[illegible]

[illegible] TOTAL [illegible]
[illegible] FLOW [illegible]
[illegible] WATER TOTAL [illegible]
STORMWATER COST [illegible]

ITEM	1 CAPITAL COST	2 EXISTING FACILITIES [illegible] VALUE	3 NET CAPITAL INVESTMENT	4 CAPITAL RECOVERY FACTOR	5 EST. MAINT. [illegible]	6 [illegible]	7 ANNUAL CAPITAL [illegible]	8 ANNUAL O&M [illegible]	9 ANNUAL [illegible]	10 [illegible]	11 ANNUAL [illegible] VALUE (1000)	12 [illegible]
TREATMENT [illegible]												
DETENTION [illegible]												
SEWERS												
PUMP STATION												
PLANT												
[illegible]												
SUB-TOTAL												
TRANSMISSION FACILITIES												
PUMP PLANT												
FORCE MAIN [illegible]												
SECONDARY PUMP PLANT												
FORCE MAIN												
[illegible]												
STORAGE RESERVOIRS												
[illegible]												
[illegible]												
[illegible]												
[illegible]												
[illegible]												
PURCHASE & RELOCATION												
[illegible]												
[illegible]												
[illegible]												
[illegible]												
PUMP STATION												
FORCE MAIN												
[illegible]												
SUB-TOTAL												
[illegible]												
DRAINAGE SYSTEM												
TILE												
[illegible]												
SUB-TOTAL												
[illegible]												
[illegible]												
[illegible]												
[illegible]												
[illegible]												
GRAND TOTAL												

CLEVELAND-AKRON METROPOLITAN
AND THREE RIVERS WATERSHED AREA
WASTEWATER MANAGEMENT SURVEY SCOPE STUDY

LAND TREATMENT

PHASE III REPORT

PREPARED
FOR
U. S. ARMY CORPS OF ENGINEERS
BUFFALO DISTRICT

UNDER CONTRACT NO.: DACW49-72-C-0051

WRIGHT-McLAUGHLIN ENGINEERS
ENGINEERING CONSULTANTS
DENVER, COLORADO

APRIL 19, 1973

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SECTION I

BACKGROUND INTRODUCTION

The Cleveland-Akron Metropolitan and Three Rivers Watershed Area wastewater management planning effort included the study of alternative wastewater treatment methods as specified in the Water Pollution Control Act Amendments of 1972.

One of the alternative methods studied in detail is land treatment as related to irrigated agriculture using treated wastewater effluent.

This report presents the findings and conclusions of the Land Treatment Contractor as defined by the scope of work for this portion of the overall effort.

Land treatment provides for reclaiming and recycling of certain pollutants and water, and the confined disposal of other pollutants not recycled. The land treatment technology provides the opportunity for revenue-producing facilities through the production of agricultural goods. It has been estimated that the readily-identifiable equivalent crop fertilizer market value of the nutrients in the effluent of the Study Area approaches $10,000,000 for 2020 flows.

The planning for this alternative has incorporated the opportunity for waste heat dissipation from power plants on a revenue-producing basis. Open space and recreational considerations have been integrated into the in-basin wastewater management facilities, and recharge of ground-water aquifers is provided in the upper Cuyahoga River valley.

The land treatment investigations have resulted in the development of wastewater management system components for Plans B and C as described in the Formulation Final Report.

Land treatment is the application of closely controlled amounts of secondarily-treated wastewater to the land surface to percolate through the soil zone for final treatment of the water and beneficial reuse of many of the pollutants as crop nutrients. The treated water is then recovered for discharge to a natural body of water, or recycled to towns and industry.

SCOPE OF WORK

The Survey Scope Study was undertaken by various organizations with specific and different assignments as follows:

1. Associated Water and Air Resource Engineers, Inc., of Nashville, Tennessee, was assigned a scope for defining industrial waste problems anticipated for 1990 and 2020, and defining the scope and cost for treatment of non-compatible wastes.
2. Havens and Emerson, Ltd., of Cleveland was assigned a scope for defining and resolving domestic and stormwater runoff problems for 1990 and 2020 and to assist in developing alternative plans.
3. Wright-McLaughlin Engineers of Denver, Colorado, was given the assignment of formulating regional management systems to include land treatment systems for ultimate disposal.

The land treatment systems are presented in this report as a part of Item 3 by the land treatment contractor.

The objective of the work of the land treatment contractor is to provide a viable alternative wastewater management plan which is based on recycling resources to agriculture, and which meets environmentally sound principles. This included three phases.

Phase I is to search out and identify land areas suitable for land treatment of wastewater. Phase II is the providing of area-wide wastewater management plans with land treatment components to meet 1983 and 1985 goals. Phase III work of the land treatment contractor is to refine the designs and costs of the land treatment components and to estimate the incremental costs associated with the phased implementation of the land treatment components.

SUMMARY OF PHASE I AND PHASE II

The detailed investigations of the Phase I and Phase II land treatment contractor's assignment are presented in those two technical appendices. Also included are supporting references. A brief summary of certain findings is presented below.

Soil Inventory

Potentially suitable lands were searched for and identified, where available, in 21 counties of the Lake Erie basin of northern Ohio. For this purpose the county soil maps, Soil Conservation Service field data, and publications of various local, state, and federal agencies were fully utilized.

In all, 1.66 million gross acres were finally inventoried as being potentially suitable for consideration. These 2600 square miles could

have been increased by incorporating other irrigation land management techniques.

The reader is referred to Sections II and III of the Phase I Land Treatment Report for detailed soil data for the 2600 square miles and the data source listing.

Geology and Ground Water Hydrology

The geology of northern Ohio is compatible with the utilization of a land treatment system for the management of the wastewaters of the study area. It is feasible to construct components such as large diameter transmission tunnels, winter storage reservoirs, and land treatment sites. Tunnels would probably be lined through limestones and shales, but supports would only need to be light. The extensive underlying glacial deposits are generally tight.

The levels and quality of ground water will not be significantly affected in the western land treatment areas by irrigation.

For more detailed discussion of the subsurface condition, Sections IV and V of the Phase I Land Treatment Report are available to the reader.

A proposed tunnel alignment to transport wastewater to the western land treatment site would traverse the Lake Erie shoreline from near Eastlake to a load point at the present Cleveland Westerly Sewage Treatment Plant and then follow a line southwesterly across Cuyahoga, Lorain and Huron Counties to a centralized winter storage reservoir site near the southwest corner of Huron County. The Transmission Tunnel route would be able to remain in the relatively more favorable shale tunneling environment for most of its length, the western portion being in limestone.

The quality of most of the existing ground water derived from the area would generally be classed as fair-to-poor, due to high TDS concentrations, as well as hardness, sulfate, hydrogen sulfide, and iron in certain areas.

A major ground water problem in the Western Land Treatment Area is the presently contaminated ground-water region centered around Bellevue. The present region of pollution extends to one mile east of Clyde and south several miles into Seneca County. This contaminated region underlies about 3,200 acres considered earlier in this study as a potential land treatment site. The condition at Bellevue illustrates the potential of well-designed land treatment systems as a means of improving a variety of hydrological conditions.

At present it is known that large springs exist on land and in Lake Erie which are discharge points for the limestone aquifer. It is estimated that perhaps 500 to 1,000 cfs total flow issues from the various springs.

In the Three Rivers Watershed a comparison of finally-selected land treatment and reservoir sites indicates that ground-water relationships present no significant constraints upon the land treatment proposals within this area. In general, relatively tight soil conditions and extremely impermeable substrata would retard ground water recharge from the winter storage reservoirs and the artificially drained irrigation sites. A system of ground and surface water quality monitoring stations would be designed for each treatment site to establish the potential hydrological impact over time of the land treatment system.

Surface Hydrology

The streams within the study area flow into Lake Erie in north-central Ohio. The major uses of surface water within the Three Rivers basin are for power and manufacturing. Lesser uses are for domestic, commercial, irrigation, and rural purposes. Some smaller towns tend to rely on ground water. As the area grows, a greater dependence upon surface water is expected, with low-flow augmentation efforts aimed at improving the low-flow condition of the streams.

The average precipitation for the State of Ohio is 37 inches per year and varies from 32 inches in northwestern Ohio to 44 inches in southwestern Ohio. The study area receives less than the average rainfall for the entire state. Although Lake Erie affects the climate near the shoreline, the main influence is from air masses moving eastward across the great plains.

In the western land treatment area, the average stream flow constantly decreases from a peak in March or April to a low in September or October when it begins to increase again. From 40 percent to 50 percent of the average annual runoff volume occurs during March and April. For an individual water year, low flows can extend into November and December, and some large winter storms between December and March can cause high peak runoff values and discharge volumes. The stream flow from June to October is generally lower than the average discharge and is less erratic from one year to the next. Summer and fall flows are less variable than winter and spring flows.

Irrigation of treated wastewater on agricultural lands will improve the low-flow conditions of the Sandusky, Vermillion and Huron river basins. The return flow will occur during the months of worst low-flow conditions and will add to the natural waters. During high-water periods, the return flow increment will not be of a sufficiently large enough proportion of the total flow to create flooding.

Within the Three Rivers Basin the return flow from land treatment would provide a beneficial increase of the low flows in the upper Cuyahoga and the upper Rocky River. The Chagrin has adequate low flows.

The natural sustained dry weather flow in the Cuyahoga below Lake Rockwell is relatively high per square mile of drainage area due to the inflow from ground water discharge. However, the municipal diversions from Lake Rockwell still cause the stream to drop to less than 10 cfs at times.

The low-flow conditions in the river between Lake Rockwell and Yellow Creek will worsen in the future without a major change in the direction of water management.

In the Rocky River, portions of which are in the area-wide park system, low-flow conditions contribute to environmental problems, particularly in the lower reaches near the more densely populated areas.

Soil Selection

The three basic techniques now used in the United States for land treatment of wastewater are rapid infiltration, spray irrigation, and overland runoff. The first requires very permeable soil and subsurface conditions, the second requires moderate permeabilities with few constraints

on subsurface geology, and the third technique operates best with very tight and impermeable soils. The techniques are defined as follows: Spray irrigation is the controlled spraying of liquid onto the land, with the flow path being infiltration and percolation within the boundaries of the site. Overland runoff is the controlled discharge of liquid onto the land, with the flow path being downslope sheet flow. Rapid infiltration is the controlled discharge, by spreading or other means, of liquid onto the land, at a rate measured in feet per week, with the flow path being high-rate infiltration and percolation.

These techniques provide for a range of soil characteristics suitable for effluent treatment which includes very tight soils with almost no permeability or infiltration capacity, to extremely coarse soils such as one would find in sand and gravel pit areas. As the type of soil criteria varies, the land treatment management and farming practices should significantly vary.

It follows that an almost infinite number of variations could be developed to suit soils falling between the coarse and fine-grained soil extremes. A selection philosophy was developed which was based on tailoring of farm management techniques to best suit specific and unique soils.

Final Selection Criteria

The final soil selection criteria was based upon testing the overall soil renovative capacity and character against specific objective and subjective measuring constraints including:

1. Reasonably high and suitably safe hydraulic capacity, as related to specific irrigation application and management methods, of more than

50 inches per year.

2. A high degree of heavy metal removal and storage capacity approaching 100 percent.

3. Nitrogen removal, with reuse, temporary storage, and atmospheric loss potential without significant leaching, of between 80 and 99 percent.

4. Phosphorous and calcium removal, with reuse or storage potential without significant leaching, approaching 99 percent.

5. Suitability for economically reasonable artificial and natural drainage control.

The constraints of present land use, because of forests, highways, homes, and general development, eliminated large areas of land from consideration for land treatment in this study. On the other hand, present agricultural and open space land use provided great areas which could be further considered in detail. In addition, some lands in northern Ohio have serious handicaps which could be greatly improved by initiation of land treatment.

The following drainage problems and needs have been described by the Great Lakes Basin Commission:

> 1. The "problem lands" are concentrated in northwestern Ohio, in an area of 5.5 million acres (four million of these are in crop and pasture land);
>
> 2. One and one-half million acres of drainage work must be done if the basin is to meet its allocation of the national requirement for food and fibers from this area.

In 1968, some 10,000 acres were irrigated in the general area west of Cleveland. In April, 1971, the Great Lakes Basin Commission pointed

out that irrigation would improve the existing form of agriculture and enable farmers to increase their income without competing for additional high value land. By choosing inadequately drained lands for land treatment purposes, additional benefits are gained because of the new drain tiling of such lands as part of the land preparation.

The final selection of the optimum lands for further consideration for use in the Cleveland-Akron-Three Rivers Wastewater Management Study resulted in the selection of three basic soil associations:

1. Mahoning-Ellsworth
2. Cardington-Bennington
3. Chili

For detailed information on the soil association characteristics, the reader is referred to the Phase I and II reports.

Farm Management

The success of land treatment areas for productive farming and ranching operations, coupled with efficient renovation of treated sewage effluent into good quality water, is dependent upon careful planning and proper farm management. The basis of this planning must include consideration of the right surface form, water application technique, soil preparation, and drainage system.

Tight, fine-grained soils have the greatest potential, if managed properly, for a high degree of sewage effluent renovation by land treatment. Sandier soils, with high permeability, suitable for conventional spray irrigation, might be selected when finer-grained soils are not

readily available near a metropolitan area, or if farming operations and traditional practices tend to prevail. In northern Ohio, both the sandy and the fine-grained soils are found.

Various farming techniques have been defined for the various soils. Most suitable methods are:

Chili -- Spray irrigation, using center-pivot rigs and solid sets, depending upon specific field configuration and size. Drainage by wells where aquifer conditions permit, and by drain tile systems elsewhere.

Mahoning-Ellsworth -- Overland runoff/infiltration method with drain tile systems. A rough grass crop would be grown.

Cardington-Bennington -- Spray irrigation, using center-pivot rigs and solid sets. Corn and grass would be the primary crops. These would be rotated. Drainage by drain tile systems.

To prepare the Mahoning-Ellsworth land for irrigation, deep plowing is contemplated to improve the soil characteristics for this purpose.

Strip-Mined Land Reclamation

The major solids by-product of any wastewater treatment is sludge, containing inorganic and decayed organic matter. This product, containing phosphorous and organic nitrogen, is suitable for application to strip-mined coal lands.

There are more than 190,000 acres of such land lying within 150 miles of Cleveland. Restoration includes three elements: (a) providing a supply of organic matter and plant nutrients, (b) improving the moisture retention capacity, and (c) reducing the acid condition at depth.

Treatment of the strip-mined lands with sludge should permit growth of numerous species of plants.

Land Treatment Components

The land is only one component of the land treatment system. To function as a comprehensive land treatment system, the wastewater must be collected, transported, pumped, applied to the land, and then returned to the stream or to the recycling process once again for use by municipalities or industry.

Basic components include:

1. Wastewater collection system
2. Secondary treatment facilities
3. Transmission conduits (pipes and tunnels)
4. Storage reservoirs
5. Land treatment site
6. Irrigation system
7. Drainage system
8. Sludge management facilities
9. Monitoring and labs.

In addition, farming operations ranging from plowing, planting and weeding to harvesting and marketing are an integral part of land treatment operations.

Aerated Lagoons

Aerated lagoons are sometimes utilized for secondary treatment of wastewater prior to land application. The secondary treatment can also be accomplished with activated sludge, trickling filter, or extended aeration plants.

Aerated lagoons are characterized by the relatively large volume of wastewater under treatment at any given time, introduction of air into the wastewater, and creation of a suitable environment for bacterial action. In many ways, it can be thought of as a slow activated sludge system, and which parallels natural processes.

Aerated lagoons are basins in which an active biological mass, oxygen, and wastewater are brought together. The resulting biological system is a variation of the activated sludge process. Wastewater organics, in the presence of oxygen, are utilized by the active mass. Therefore, the basic biological relationships pertinent to activated sludge apply to aerated lagoons.

The particular lagoon system proposed for this study consists of two stages: the first stage, or aerobic lagoon; and the second stage, or facultative lagoon. The amount of mixing created by the aeration equipment is the distinguishing factor between the two lagoons. An aerobic lagoon is one in which mixing keeps the solids in suspension.

Wastewater Renovation

The renovative capacity and efficiency of the land treatment systems vary from soil to soil, with crops grown, with the character of irrigation and drainage, and with the quality of the effluent being applied as irrigation water.

The following table presents the projected quality of the irrigation water following secondary biological treatment and assuming a mix 81 percent municipal-industrial sewage and 19 percent storm water. The concentrations shown are conservatively high for computational purposes.

TABLE I-1

IRRIGATION WATER QUALITY

Constituent	Municipal-Industrial and Combined Wastewater (mg/l)	Storm Runoff (mg/l)	Municipal-Industrial Combined and Storm Runoff (mg/l)
Suspended Solids (SS)	25	25	25
Biochemical Oxygen Demand (BOD)	15	15	15
Chemical Oxygen Demand (COD)	69	69	69
Total Dissolved Solids (TDS)	520	200	460
Nitrogen (N)	19.7	2.2	16.4
Phosphorous (P)	10.2	0.5	8.3
Heavy Metals	2.0	0.2	1.7

The quality of the western land treatment site drain tile effluent, after treatment, is represented in the following table along with the quality of storm runoff return flow. The sandier Chili soil would provide an effluent with a slightly higher BOD, COD, and N than that of the Cardington-Bennington soils.

Layout of drain tile systems has been undertaken to permit early spring planting without a high water table problem as now occurs in some years. The water table will decline rapidly enough following irrigation, and the aeration requirements will be met. Studies show that with average application rates of 120 inches per year on Cardington-Bennington soils, 30-foot spacings would be adequate for tiles. Closer spacing has been selected, however. Using the center-pivot rig on the Cardington-Bennington

soils at average rates of 120 inches per year, the soil zone would be constantly in an aerated condition.

TABLE I-2

WASTEWATER RENOVATION OF SECONDARY EFFLUENT

	Municipal/Industrial/Combined Cardington-Bennington Soils		Storm Runoff Mahoning-Ellsworth Soils
Constituent	Removal Rate (Percent)	Return Flow (mg/l)	Return Flow (mg/l)
SS	99	< 0.3	< 0.3
BOD	99	< 0.2	< 0.2
COD	99	0.7	0.7
TDS	5-10	450-500 **	150-200 **
N	85-95 *	$< 1 - 2.5$	< 0.1
P	99+	< 0.1	< 0.01
Metals	99+	Trace	Trace
Virus	99+		
Bacteria	99+		

* The removal rate will depend on the crops grown, yields, and product removal. Unexplained losses of up to 50 percent to the atmosphere may occur.

** Average values are shown; lower or higher values are possible, depending on rainfall and evapotranspiration rates.

The approximate difference between ordinary alfalfa hay and typical Reed Canarygrass irrigated by sewage effluent with a good supply of nutrients is shown below:

	Protein %	Fiber %	TDN %	Phos. %	Nitrogen %	Dry Matter %
Alfalfa Hay	14.7	29	50.3	.21	2.35	90.4
Reed Canarygrass	20+	27	60	0.5	3	92

THE LAND TREATMENT SYSTEM

The land treatment system consists of a series of components including:

1. Sewage collection system
2. Secondary treatment
3. Pumping and transmission pipe for wastewater
4. Winter storage reservoir
5. Pumping and distribution to farms after chlorination
6. Irrigation application equipment
7. The soil (living filter)
8. Subsurface drainage
9. Canals and conduits
10. Sludge treatment.

In a combined sewerage system, the stormwater is treated with the municipal/industrial wastewater. Detention storage is provided to reduce the peak rate of storm runoff so that the transmission pipe can be sized for a controlled flow level.

In a separate stormwater sewerage system, the runoff is detained to reduce the peak of the hydrograph. When the storm runoff is released, it may be mixed with the municipal/industrial wastewater prior to treatment; then the combined storm runoff and the municipal/industrial

wastewater receive secondary treatment. When it is more cost-effective, the stormwater bypasses secondary treatment and is mixed with municipal/ industrial secondary effluent. In either case, the treated effluent is then transported to winter storage.

With minor variations, the above described process is used in all 23 municipal/industrial land treatment systems in Plan C.

In a completely separate stormwater treatment system the water is detained in basins, then transported directly to the winter reservoir without being mixed with municipal/industrial wastewater.

COSTING

The planning effort included detailed costing of land treatment components so that overall costing could be accomplished by the Formulation Contractor, and meaningful cost comparisons made.

The reader is referred to Section VI of the Land Treatment Phase II Report for detailed costing data, and to Section IV and the Cost Appendix of this report.

The following five sections of this report provide schematic designs, farm management and treatment performance estimates, incremental costs on a time-phased basis, a discussion of early-action recommendations, and a tabulation of resource requirements for land treatment alternatives.

SECTION II

SCHEMATIC DESIGNS -- LAND TREATMENT COMPONENTS

Land application of wastewater effluent from secondary biological treatment facilities is referred to as land treatment. Secondary biological treatment may be accomplished in aerated lagoons or conventional secondary treatment plants. For separate storm runoff, the treatment prior to land application consists of pre-treatment followed by three to thirty days storage in detention basins. From the detention basin, the storm runoff may be released to a sanitary sewer during off-peak periods for secondary treatment in a municipal sewage treatment plant, or it may be given separate preliminary treatment and then pumped directly to a winter storage reservoir. For both the municipal/industrial wastewater and the storm runoff, all of the wastewater is eventually pumped to separate or combined reservoirs prior to land treatment.

No land treatment of wastewater effluent or storm runoff is included in Plan A. In Plan B, all of the wastewater from the upper-basin municipal plants, except Kent and Akron, goes to land treatment sites. In addition, land treatment of storm runoff, where feasible, is included in Plans B and C. Plan C provides for land treatment of those in-basin plants included in Plan B plus Kent, as well as land treatment in western Ohio for the wastewater from the shoreline plants. The reader is referred to the Formulation Final Report for a description of the Plan C wastewater system.

CRITERIA AND SCHEDULING

The wastewater management goals for Phase III are based upon the guidance provided by the Corps of Engineers (NCBED-PB, 31 January 1973) to comply with the Corps' interpretations of the Federal Water Pollution Control Act Amendments of 1972. The proposed State of Ohio effluent standards, the O. C. E. goals, and Level and Level 2 criteria, are summarized in Table II-I of the Formulation Final Report. New construction or expansion will be phased according to the following schedule:

Municipal and Industrial Wastewater

a. Secondary treatment by 1977

b. Level 1 by 1983

c. Level 2 by 1985

Storm Runoff and Combined Sewer Overflows

a. Combined overflow to Level 1 by 1980

b. Separate storm runoff to Level 1 by 1983, except for the separate basins tributary to the tunnel.

c. All runoff treatment to Level 2 by 1985.

LAND TREATMENT COMPONENTS

1. Aerated Lagoons are planned to begin operation by 1977 for the 23 small in-basin municipal plants in Plan C. For Plan B, however, the Kent plant would be a physical-chemical treatment plant. Except for the early-action projects at Burton and New Medina, which will receive land treatment in 1977, the

effluent from the aerated lagoons will be discharged to streams and rivers until 1983. Thereafter, the effluent will be pumped to the land treatment reservoir sites. To assure adequate BOD and SS removals during the 1977-1983 period, the activated lagoons built in 1976 are oversized by 50 per cent or more. The schematic design, operation, and removal efficiencies of the aerated lagoons are discussed in Section IV of the Land Treatment Phase II Report.

2. <u>Municipal Land Treatment In-Basin on Chili Soils</u> occurs primarily in the Cuyahoga River Basin. The design criteria for these sites are listed below:

Application rates:	60 inches per year
Irrigation System:	Sprinklers by solid set or center pivot
Crops	Corn and Reed Canary Grass
Drainage system:	Depth = $5\frac{1}{2}$ feet Spacing = 60 feet
Site criteria:	Buffer strips of 100 feet near residences
Winter storage:	113 days
Special provisions:	Optional deep plowing

3. <u>Municipal Land Treatment In-Basin on Mahoning Soils</u> occurs in the Chagrin and Rocky River Basins. The design criteria for these sites are listed following:

Application rates:	90 inches per year
Irrigation system:	Border Method (overland-flow/infiltration)

Crops:	Reed Canary Grass
Drainage system:	Depth = 3 feet Spacing = 20 feet
Site criteria:	No buffer strips
Winter storage:	85 days
Special Provisions:	Optional deep plowing

4. Separate Storm Runoff Land Treatment In-Basin as distinguished from storm runoff that is treated in the municipal plants with the domestic and industrial sewage, receives considerably less pre-treatment, consisting of settling for three days in a detention basin followed by storage and stabilization in the winter storage reservoir prior to land treatment. Where this stormwater is to be applied to the Mahoning soils at a rate of 150 inches per year, separate storage reservoirs are planned. For the Chili Soils, where the application rate is maintained at the municipal sewage effluent rate of 60 inches per year, the storm water is pumped from the detention basin directly to the municipal winter storage reservoir, where economically advantageous.

The design criteria for separate storm runoff are summarized below:

	Soil	
	Chili	Mahoning
Application rates:	60 inches per year	150 inches per year
Irrigation System:	Center pivot or solid set	Border Method
Crops:	General	Reed Canary Grass

	Soil	
	Chili	Mahoning
Drainage system:	Depth = $5\frac{1}{2}$ feet Spacing = 60 ft.	Depth - 3 feet Spacing = 20 feet
Winter storage:	113 days	85 days
Site criteria:	No buffer strips	No buffer strips
Deep plowing:	Optional	Yes

The various farm management and irrigation methods for the different soils are discussed in Section IX of the Land Treatment Technical Appendix. Golf courses may be used in lieu of agricultural land where feasible. However, the application rates would be reduced unless adequate subsurface drainage were provided.

5. Combined Sewer Overflow Temporary Treatment for 1980-1985 is accomplished by providing tunnel and mined storage in addition to concrete basins for the one-year storm and treating this wastewater at the Southerly, Westerly, and Easterly treatment plants over a three-day period for the design storm. This plan calls for building the T-section connecting the above plants, constructing the mined storage in this segment and installing temporary pumps at the three plants. This component applies only to Plan C.

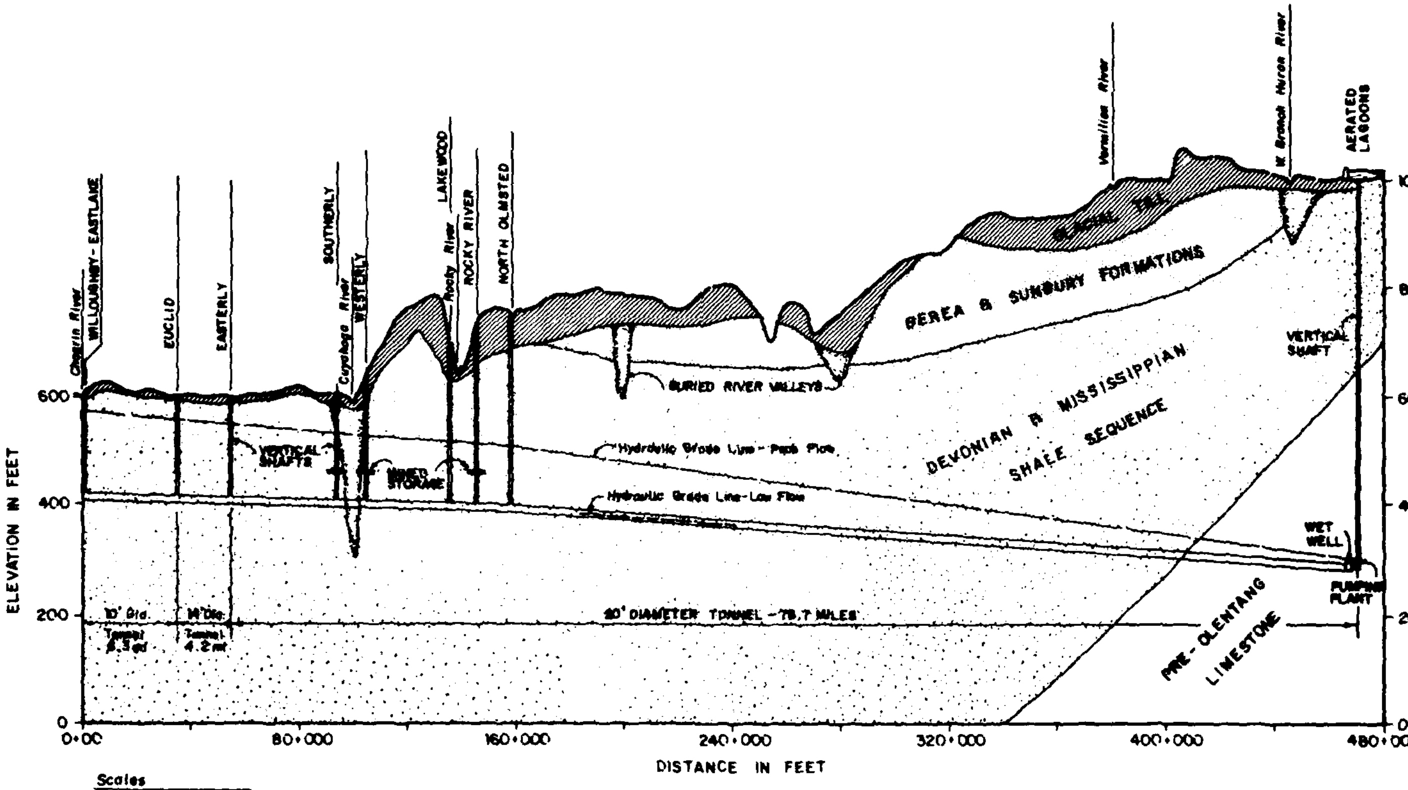
6. The Transmission Tunnel consists of a lined tunnel ninety-one miles long beginning at Willoughby-Eastlake and terminating at the aerated lagoons of the western Ohio land treatment site. The purpose of this tunnel is to transmit the municipal and industrial wastewater from the shoreline plants to western Ohio. In addition, this tunnel, coupled with surface detention storage and tunnel-mined storage, is capable of transmitting the one-year storm runoff

from the Cleveland metropolitan area. The main tunnel varies in size from ten feet in diameter to twenty feet in diameter, as shown on Figure II-1. Several tunnel spurs connecting the plants of Southerly, Rocky River, Lakewood, and North Olmstead to the main tunnel are also necessary. Other spurs and shafts will allow access for storm runoff. **The Tunnel component applies only to Plan C.**

a. Geological Formations are shown on Figure II-1. For the the most part, the tunnel goes through shale formations, the Devonian and Mississippian Shale Sequence. The last segment of the tunnel penetrates Pre-Olentang limestone. Except for the sections which run through buried river channels, it is anticiapted that moling machines will be used to excavate the tunnel.

b. Lining in the form of reinforced concrete from one foot to two feet, depending on the tunnel diameter, will be utilized. Special provisions may be required for the tunnel in the old river channel under the Cuyahoga River.

c. Capacity of the tunnel for the maximum section and maximum hydraulic grade line will exceed 1,800 MGD. For normal domestic and municipal flows of 550 MGD, the twenty-foot tunnel will flow about half full at a velocity of six feet per second. During peak stormwater runoff coincident with peak domestic and municipal flows, the maximum discharge will be approximately 1,730 MGD with



Scales
Hor. 1" = 40,000'
Vert. 1" = 200'

TUNNEL PROFILE
AND
GEOLOGICAL FORMATIONS

FIGURE II-1

velocities of about 8.5 feet per second.

d. Surcharge Storage, or mined storage chambers, consisting of wall and pillar construction will be provided to store large intermittent wastewater flows. Reading from left to right on Figure II-1, the mined storage chambers are to have a capacity of 180, 50, and 150 MG (million gallons). Another large storage chamber of 280 MG will be constructed in the Southerly spur at about the point the CU-2 drainage basin runoff enters the tunnel via a drop shaft. At this point, the tunnel would be reduced from a fourteen-foot diameter to a ten-foot diameter for the purpose of limiting the maximum flows into the main tunnel. The detention time of the mined storage chambers will vary from one to twelve hours for the one-year storm runoff depending on the storm pattern, storm frequency, and the storm's coincidence with the municipal and industrial peak flows.

e. Sediment Buildup is not expected to occur because of the velocities in the tunnel which vary between six and eight feet per second. Pre-treatment of the wastewater flows will remove debris and trash. Provision at the end of the tunnel for collection and removal of the large particles will be made.

f. Aeration will be provided at ten-mile intervals to avoid

septicity of the wastewater which requires about a twenty-hour travel time through the tunnel.

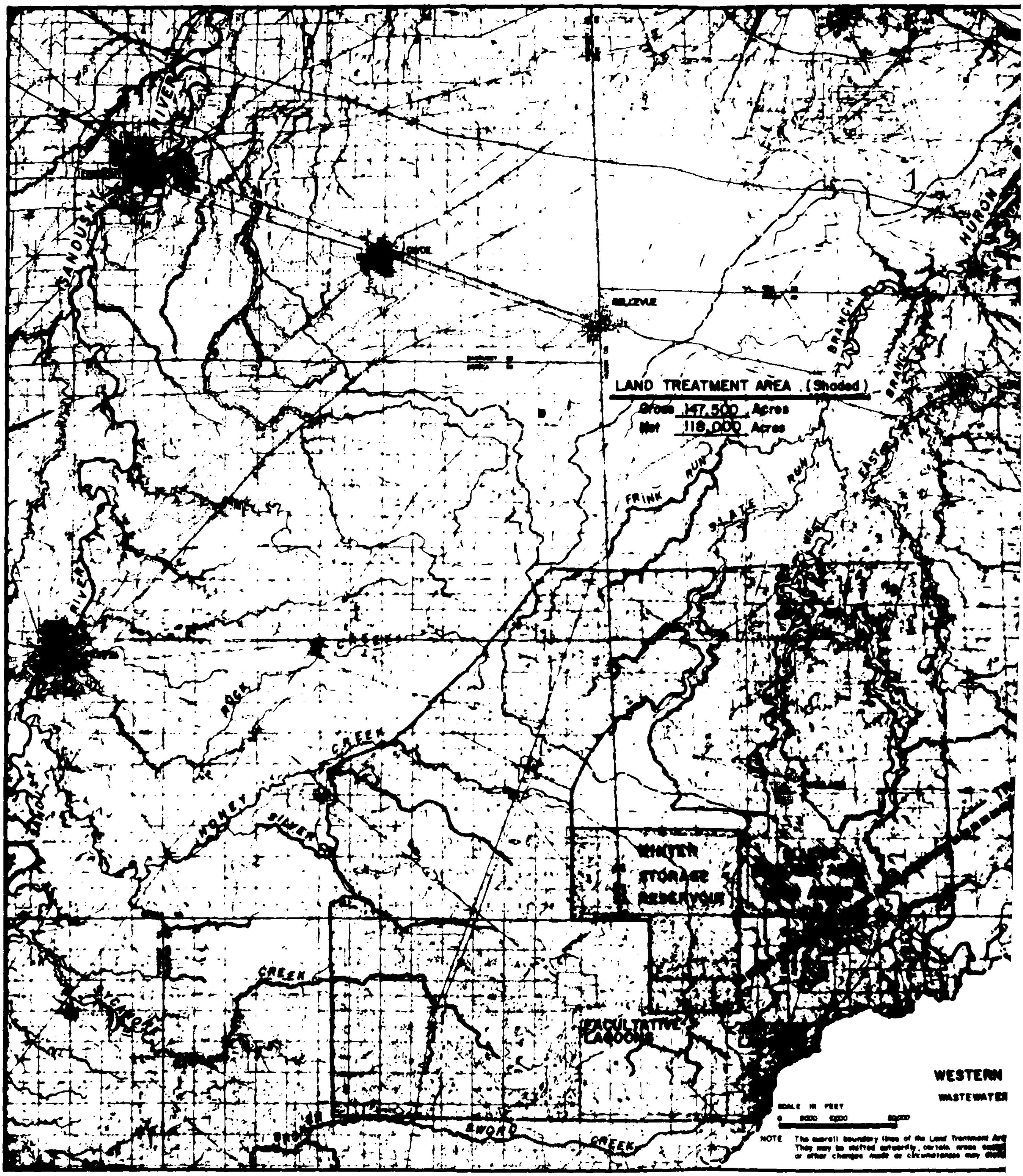
g. Standby Power will be provided at the end of the tunnel in case of a power interruption. Storage will also be provided at that location.

h. Construction Timing. The initial construction of the tunnel for the temporary combined storm runoff will give the contractors and planners valuable experience regarding construction methods, cost estimates, and scheduling. For cost-phasing purposes, construction of the tunnel will occur prior to 1985.

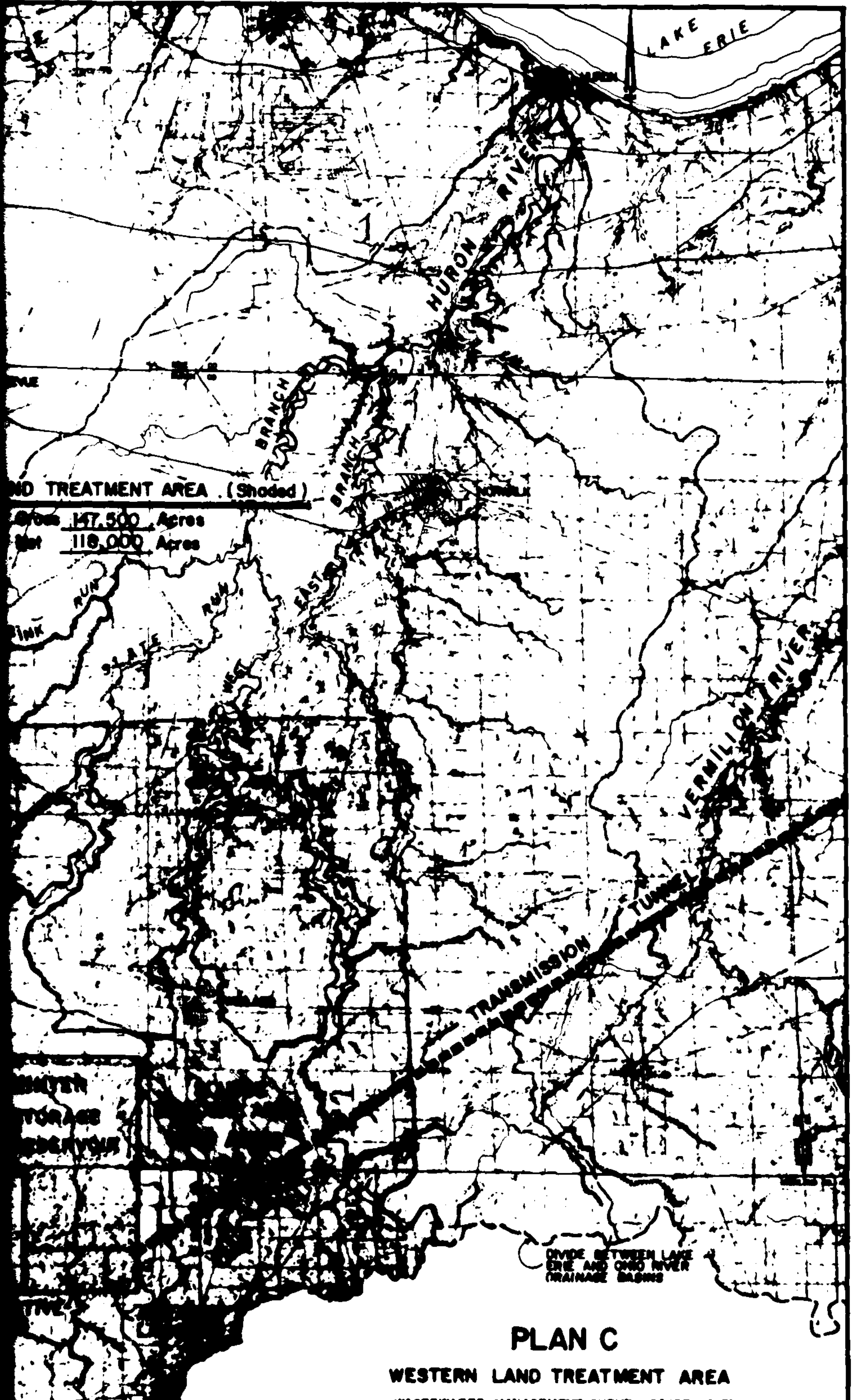
7. The Western Land Treatment Area for Plan C consists of 118,000 net irrigated acres to treat an average annual wastewater flow of 240,000 MG, based on an application rate of 75 inches per year. An additional 4,000 acres will be required for land treatment of sludge. These areas are depicted on Figure II-2.

a. Aerated Lagoons and Facultative Lagoons are discussed in depth in Section IV of the Land Treatment Phase II Report. Because of the delay until 1990 in phasing out secondary treatment at the shoreline plants, the aerated lagoons at the Western Land Treatment Area will not become operational until that year.

b. The Winter Storage Reservoir for the Western Land Treatment Area is shown on Figure II-2. As located, the



LAND TREATMENT AREA (Shaded)
Gross 147,500 Acres
Net 118,000 Acres
SANDUSKY RIVER
HURON
BRANCH
EAST BRANCH
FRINK RUN
SLATE RUN
ROCK CREEK
HONEY CREEK
SILVER
WATER STORAGE RESERVOIR
FACULTATIVE LAGOONS
SWORD CREEK
BELLEVUE
WESTERN
WASTEWATER
SCALE IN FEET



PLAN C

WESTERN LAND TREATMENT AREA

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY

NOTE The overall boundary lines of the Land Treatment Area shown are not inflexible. They may be shifted outwardly, certain areas excepted inside the area defined, or other changes made as circumstances may dictate

FIGURE II- 2

2

effluent from the facultative lagoons will flow by gravity into the winter storage reservoirs, which will consist of sixteen to eighteen large cells of about 15,000 MG each for a total storage volume of over 84,000 MG. The uninterrupted storage period is expected to be 113 days, or about sixteen weeks. The materials for the dikes will come primarily from excavation of the soil within each cell. Riprap for the inside banks will be required to prevent erosion of these banks. A minimum freeboard of six feet will be provided. The shape of the cells, as well as maximum water level differentials, will depend on the topography.

For the period 1985 through 1990, before any of the shoreline treatment plants are phased out and any of the aerated lagoons are operational, the winter reservoir will receive secondary-treated effluent directly. The occasional slugs of untreated stormwater coming into the system during the 1985-1990 period will be highly diluted when combined with the treated effluent in the storage reservoir and no problems are anticipated prior to the operation of the aerated lagoons in 1990.

c. Reservoir Rainfall and Evaporation. The winter storage reservoirs will gain water from precipitation and lose part of this water by evaporation. For the 10-year period,

1961 - 1970 inclusive, the average precipitation at the Tiffin, Ohio, weather station was reported to be 34.13 inches. The closest station with complete evaporation records is at Wooster, Ohio, which reported an average pan evaporatior of 39.46 inches. This would amount to an average annual evaporation of approximately 28 inches using a pan coefficient of 0.70 which would create an annual surplus of about six inches.

During the normal storage period, November through March, little evaporation would occur. The precipitation during this period is approximately 12 inches. Until 2020 there would normally be excess reservoir storage capacity to absorb this excess. At 2020, the reservoir would fill up by the end of the storage season and begin to encroach on the six feet of freeboard provided. For the short time period involved, this freeboard encroachment will not impose a hazard to the embankment.

The excess of rainfall over evaporation in the reservoir will provide a dilution of total dissolved solids in the same manner as does storm runoff, benefitting the effluent quality all year long.

d. Irrigation Pumping Plants. For cost purposes, four pumping plants adjacent to the reservoir, are planned. Buried force mains to the land sites will decrease in diameter from the pumping plant to the land farthest away from the

reservoir. Booster pumps may be or may not be required depending on final design considerations.

e. Irrigation Equipment and Drainage Systems have been discussed in Section III of the Land Treatment Phase II report.

f. Crops grown at the Western Land Treatment Area will be corn and Reed Canary Grass covering approximately 40 percent and 60 percent respectively of the irrigated acreage. This subject is more thoroughly discussed in the following section of this report.

SLUDGE MANAGEMENT

A cost study was made to determine the most feasible methods of sludge handling and disposal. Comparisons were made between the transportation of liquid sludge via truck or pipeline to agricultural lands, the transmission of liquid sludge via pipeline to the strip-mined area, the transportation of dry sludge via truck to agricultural lands, and the incineration of sludge at the treatment plants. In each case, available lands and their relation to the treatment plant site, were considered in choosing the best method of sludge handling and disposal for each plant. In addition, the particular phasing requirements for Plans A, B, and C were considered in choosing the methods of sludge management.

The cost comparisons considered varying plant sizes, liquid and dry sludge application techniques, and the distance from the treatment plant to the application site. These were plotted to

determine graphically the optimum method of disposal for each plant with its initial and ultimate size considered in the choice of sludge management. For example, a small plant whose initial capacity would warrant liquid sludge trucking, might require a pipeline with the future expansion of the plant. In this case, to build pipelines initially would be more economical than to phase out trucks and build pipelines and pump stations later.

In-Basin Agricultural Application

Liquid sludge is pumped from the digester to sludge holding tanks located on the treatment plant site or immediately adjacent. Storage capacity is sized for six months, assuming a six-month irrigation season. During the irrigation season, sludge is pumped from the storage holding tanks into liquid sludge trucks. Trucks would be equipped for highway travel and for crossing agricultural fields while applying the sludge. The use of six-month storage takes into account inclement weather and holidays.

Liquid sludge trucking appeared most efficient in plants having 0.5 to 10.0 MGD capacity. For certain small plants, e.g. East Claridon and Troy Township, it was shown to be more economical to digest the sludge and dewater on sand drying beds. Periodic removal of the dried sludge to agricultural lands in adjacent areas would replace liquid sludge trucking and be most cost effective.

For plants larger than 10.0 MGD but smaller than 15.0 MGD, vacuum filtration and truck transport of the dried sludge proved more economical than either liquid sludge trucking or pipeline transmission.

In the case of vacuum filtered sludge, storage is again supplied for the dried sludge over the winter months. This necessitates building sludge storage basins, preferably near the land application sites. The vacuum filtered sludge would be trucked and dumped into the storage basins, stored, and removed for the summer land treatment season. Capital expenditures would include trucks, sludge storage basins, and sludge removal equipment, with the capital cost of sludge spreading equipment born by the user. Storage capacity would also be for an approximate six-month period.

Pipeline transmission of liquid sludge proved more cost effective than either the liquid sludge trucking, or the vacuum filtration/trucking systems when larger volumes of sludge were involved. In this case, liquid sludge would be piped to sludge holding tanks adjacent to the application sites. Again, storage would be for the six-month period with the total sludge volume withdrawn and applied over the five to six-month irrigation season. Capital costs for sludge pipelines are high compared with other systems of handling, and the permanence of the pipeline dictates the continued use of this method and adjacent agricultural lands.

In isolated instances, the most economically feasible method of sludge disposal was incineration. This applied where incinerators were already in use, and would continue for their useful life. The residue or ash from the incineration process was disposed of by land fill.

Strip-Mine Renovation

Plans A and B employ a method of sludge disposal which includes

constructing a pipeline to connect Euclid, Easterly, Southerly, Akron and Ravenna with the strip-mined lands. This required approximately 120 miles of pipe. An annual total of ten months of sludge application is expected to be feasible on the strip-mined lands.

Because of the large volume of sludge from those plants using the strip-mined area, storage in lagoons proved more economical than the construction of concrete or steel holding tanks. Capacity was provided for a two-month storage period.

Costs for agricultural application of liquid sludge include:

Pump stations

Liquid sludge holding tanks

Sludge hauling trucks/spreaders

Land purchase

Costs for agricultural application of vacuum-filtered sludge include:

Sludge hauling trucks

Storage basins

Sludge removal equipment

Sludge hauling and spreading equipment (privately owned)

Costs for agricultural application via liquid sludge pipeline include:

Sludge pump stations (booster stations where required)

Pipelines

Liquid sludge holding tanks (lagoons)

Sludge removal pumping equipment

Distribution systems/trucks

Land purchase.

Sludge management facilities were chosen to optimize costs, with consideration given to available agricultural land, synergistic benefits and phasing. In addition, operation and maintenance costs were a key factor in the overall design capabilities of the plant. For liquid sludge application, truck drivers, land management personnel and storage basin operators will be required. The vacuum-filtered sludge applications required personnel to operate sludge holding basins, drive trucks, and manage sludge distribution centers. Liquid sludge pipelines required personnel to maintain pump stations, operate sludge holding tanks and sludge distribution centers in addition to operation of liquid sludge dispensing equipment. Sludge piped to strip-mined areas requires similar personnel and operations as liquid sludge to agricultural lands. In all cases mechanics, laborers, operators, secretarial personnel, etc., are required to operate and maintain these sludge management systems.

Sludge Application Rates

On agricultural land, the projected sludge application rate is ten dry tons per acre per year. The amount applied at one time can be varied depending on the cropping pattern, crops grown or equipment used to apply the sludge. Application of 30 dry tons in one year with a two-year rest period is an alternative. Monitoring the release of nutrients and its effect on the drainage effluent would be required for a number of years to optimize the rate of application.

On strip mines, an application rate of 200 dry tons per acre every ten years has been projected for costing. Initially higher application rates may be permissible.

TABLE II-1

PLAN C COMPONENT SUMMARY FOR 2020 CONDITIONS
MUNICIPAL/INDUSTRIAL WASTEWATER ONLY

Plant	Projected Population (2020)	M&I/ADF (MGD)	Secondary Treatment	Winter Storage (MG)	Soil Type	Area Irrigated (Acres)	Application Method	Application Rate In/Yr.	Drain Tile Depth (Ft)	Drain Tile Spacing (Ft)	Crops	Sludge Treatment
Randolph	5,000	0.75	AL	85	Chili	168	SS, CPR	60	5½	60	C, RCG	Ag. Land
New Kent	150,600	28.41	AL	2,785	Chili	5,522	SS, CPR	60	5½	60	C, RCG	Ag. Land
Burton	13,300	3.61	AL	408	Chili	809	SS, CPR	60	5½	60	C, RCG	Ag. Land
Mantua	3,975	0.86	AL	97	Chili	193	SS, CPR	60	5½	60	C, RCG	Ag. Land
Butternut Creek	7,800	1.17	AL	132	Chili	262	SS, CPR	60	5½	60	C, RCG	Ag. Land
Chardon	13,300	0.20	AL	17	Mahoning	30	OVF/INF	90	3	20	RCG	Ag. Land
East Claridon	3,200	0.48	AL	54	Mahoning	108	OVF/INF	90	3	20	RCG	Ag. Land
Troy Township	3,140	0.47	AL	53	Chili	105	SS, CPR	60	5½	60	C, RCG	Ag. Land
Auburn Township	5,600	0.84	AL	95	Chili	188	SS, CPR	60	5½	60	C, RCG	Ag. Land
Shalersboro	13,333	2.00	AL	226	Chili	448	SS, CPR	60	5½	60	C, RCG	Ag. Land
Ravenna	74,315	12.34	AL	1,394	Chili	2,764	SS, CPR	60	5½	60	C, RCG	Ag. Land
Aurora Central	16,285	2.98	AL	253	Mahoning	445	OVF/INF	90	3	20	RCG	Ag. Land
Fairmount Road	22,680	3.40	AL	384	Chili	762	SS, CPR	60	5½	60	C, RCG	Ag. Land
Fowler's Road	13,200	1.98	AL	224	Chili	444	SS, CPR	60	5½	60	C, RCG	Ag. Land
Newbury Township	10,300	1.54	AL	131	Mahoning	230	OVF/INF	90	3	20	RCG	Ag. Land
Chagrin Falls	51,296	7.87	AL	669	Mahoning	1,176	OVF/INF	90	3	20	RCG	Ag. Land
Chagrin East Branch	13,020	1.95	AL	166	Mahoning	291	OVF/INF	90	3	20	RCG	Ag. Land
Upper East Branch	7,333	1.11	AL	94	Mahoning	166	OVF/INF	90	3	20	RCG	Ag. Land
Hinckley	11,470	1.72	AL	146	Mahoning	255	OVF/INF	90	3	20	RCG	Ag. Land
Medina County	33,333	5.00	AL	425	Mahoning	747	OVF/INF	90	3	20	RCG	Ag. Land
New Medina	49,666	9.49	AL	807	Mahoning	1,418	OVF/INF	90	3	20	RCG	Ag. Land
Ma[illegible]et Creek	4,000	0.60	AL	68	Mahoning	134	OVF/INF	90	3	20	RCG	Ag. Land
[illegible]e Pool	33,333	5.00	AL	425	Mahoning	747	OVF/INF	90	3	20	RCG	Ag. Land
[illegible] and Treatment Area	2,618,522	549.21	AL	62,061	Cardington-Bennington	98,473	SS, CPR	75	3	20	C, RCG*	Ag. Land

[illegible]:
OVF/INF - Overland Flow/Infiltration
SS - Solid Set Sprinkler
CPR - Center Pivot Rig
AL - Aerated Lagoons

C - Corn
RCG - Reed Canary Grass
Ag. Land - Agricultural Land

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CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA. W--ETC(U)

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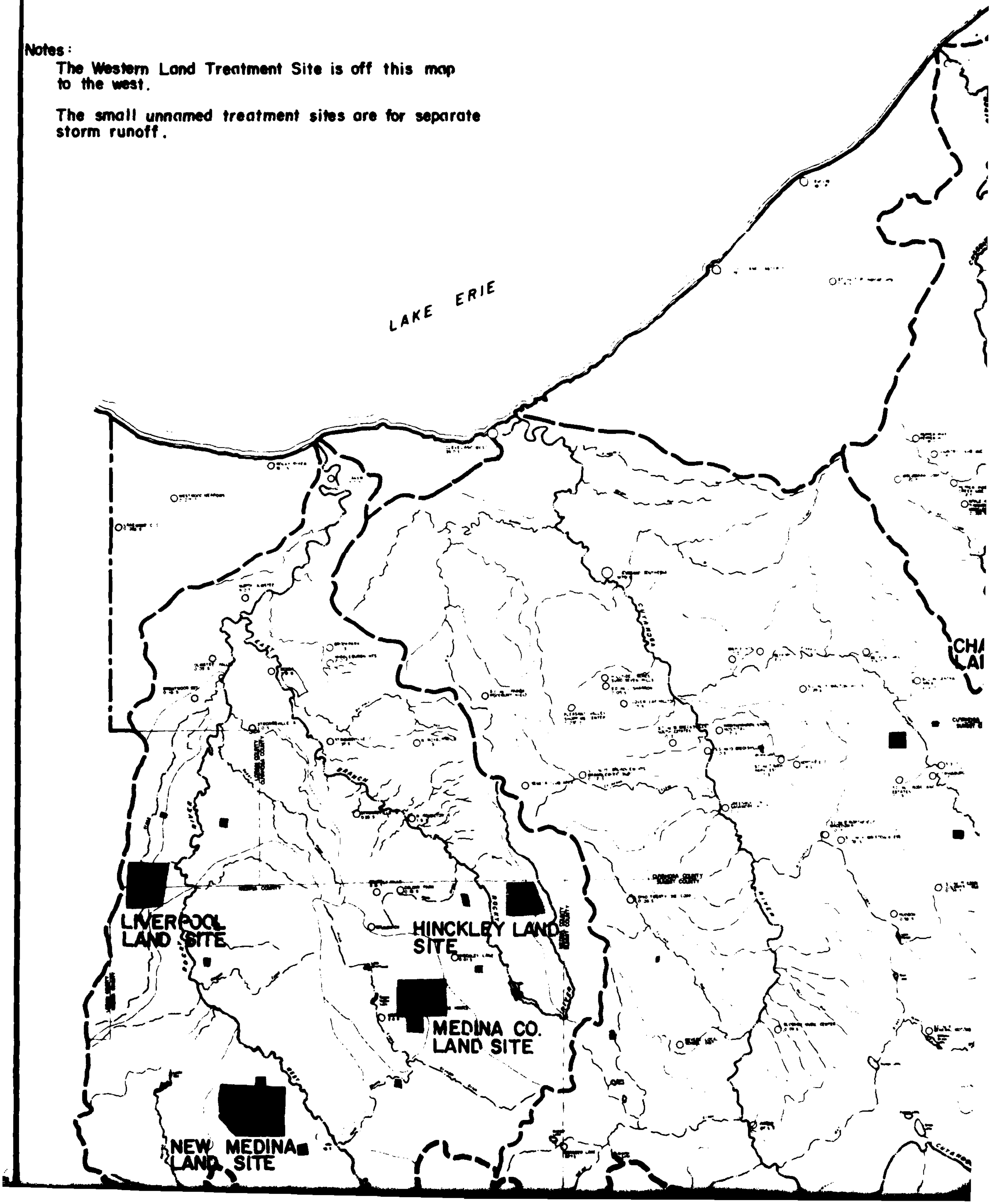
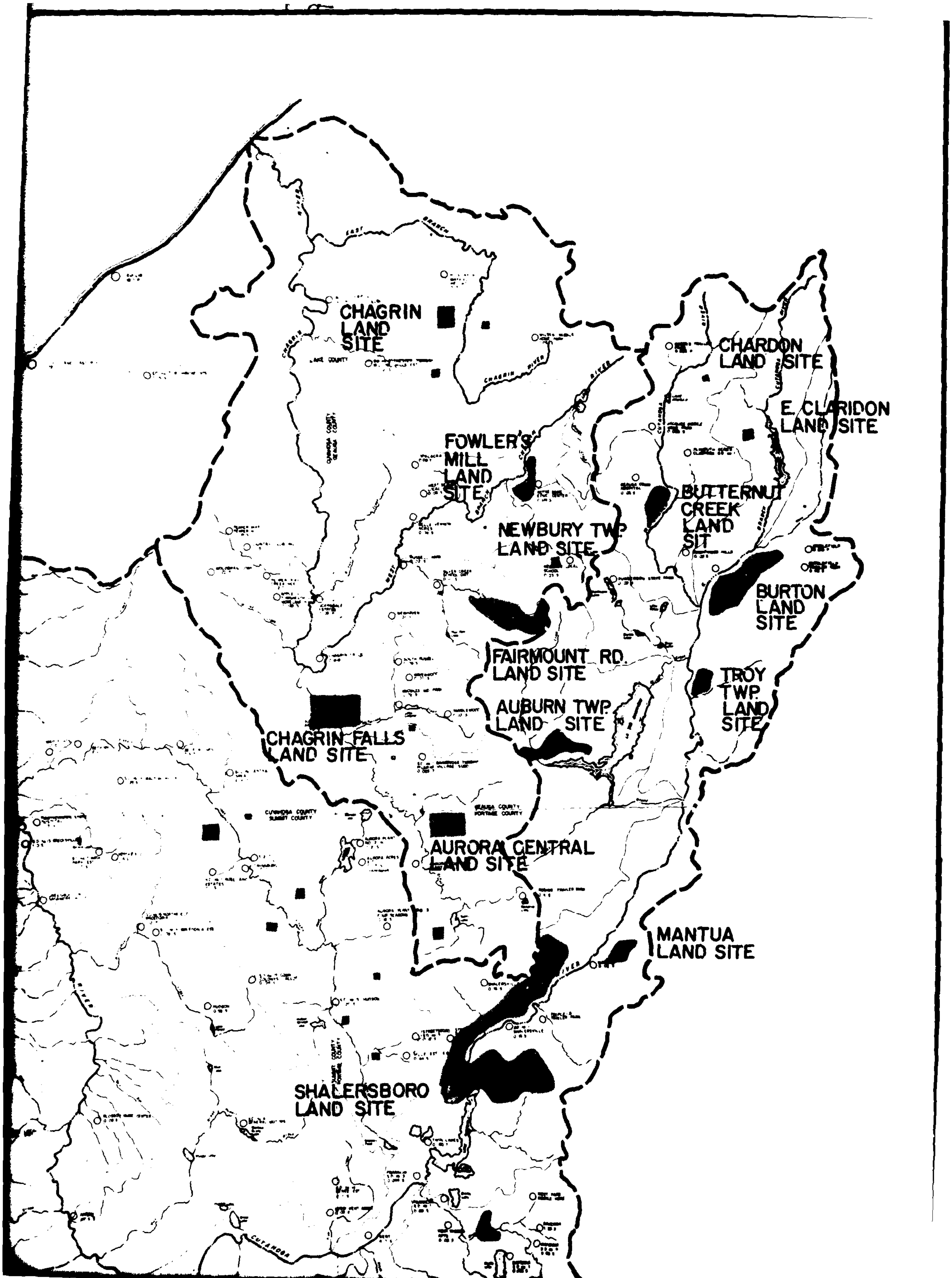
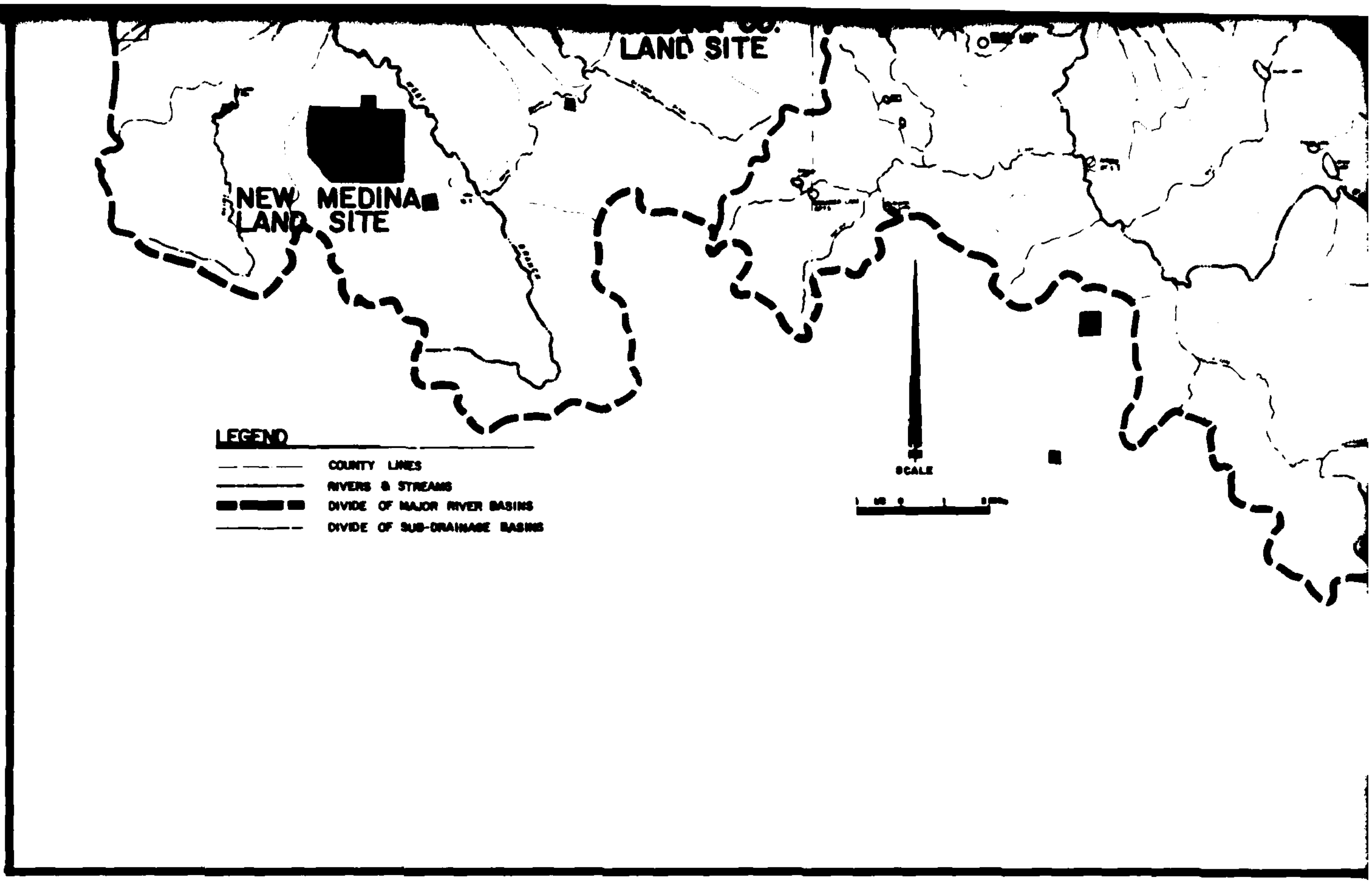
Notes:

The Western Land Treatment Site is off this map to the west.

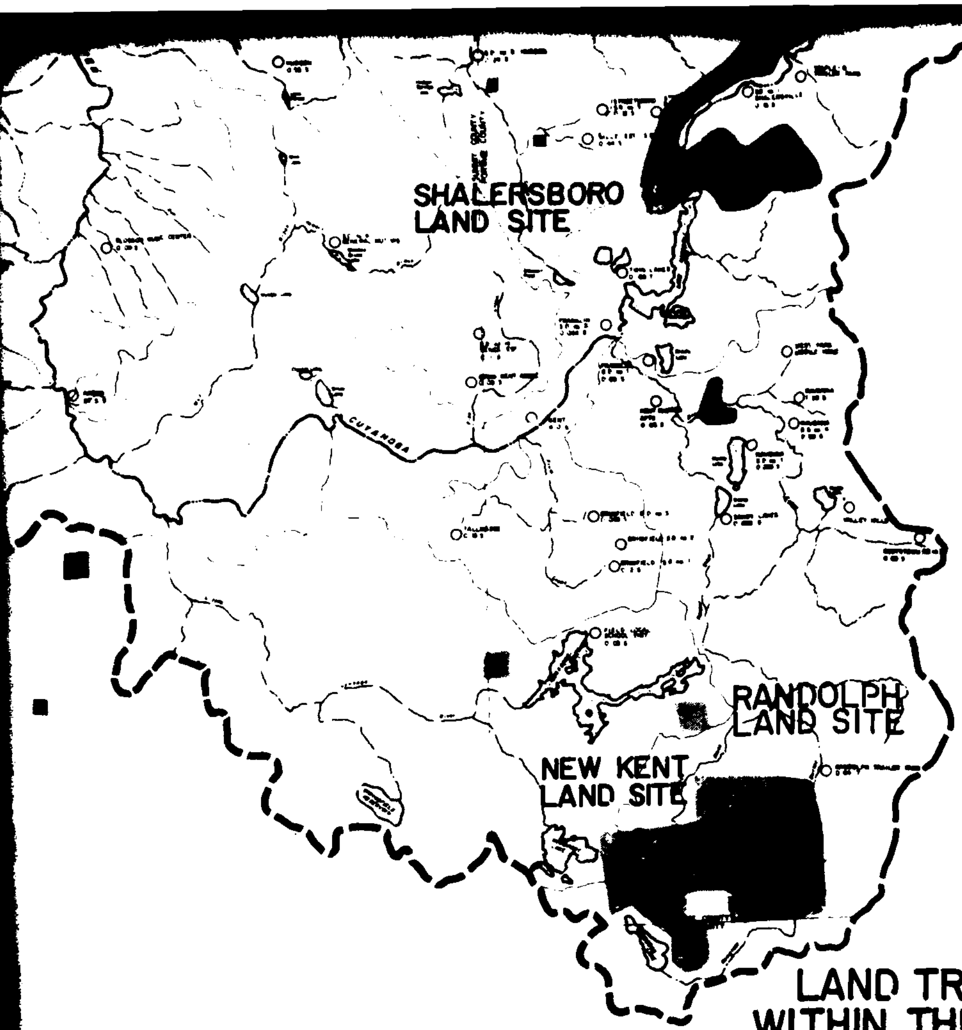
The small unnamed treatment sites are for separate storm runoff.




CHAGRIN LAND SITE
CHARDON LAND SITE
E. CLARIDON LAND SITE
FOWLER'S MILL LAND SITE
BUTTERNUT CREEK LAND SIT
NEWBURY TWP. LAND SITE
BURTON LAND SITE
FAIRMOUNT RD. LAND SITE
TROY TWP. LAND SITE
AUBURN TWP. LAND SITE
CHAGRIN FALLS LAND SITE
AURORA CENTRAL LAND SITE
MANTUA LAND SITE
SHALERSBORO LAND SITE
CHAGRIN RIVER
CUYAHOGA


LAND SITE
NEW MEDINA
LAND SITE
LEGEND
COUNTY LINES
RIVERS & STREAMS
DIVIDE OF MAJOR RIVER BASINS
DIVIDE OF SUB-DRAINAGE BASINS
SCALE

3



LAND TREATMENT SITES
WITHIN THREE-RIVERS BASIN
FOR PLAN C

FIGURE II-3

SECTION III

FARM MANAGEMENT TECHNIQUES

OPERATION AND PERFORMANCE OF LAND TREATMENT SYSTEMS

Farm management varies from soil to soil. For optimum performance the management techniques must be specifically designed and operated to meet the physical and environmental constraints peculiar to each location.

Farm management for the Mahoning-Ellsworth soil association would utilize the overland-flow/infiltration method for both municipal/industrial wastewater and separate storm runoff.

On Chili soils, spray irrigation would be employed with center-pivot rigs and solid-set sprinklers.

The Western Land Treatment Area, which accounts for the major portion of irrigated lands in Plan C, is located on Cardington-Bennington soils, where center-pivot rigs and solid-set sprinklers would be used. The Western Land Treatment Area is shown in Figure II-2.

WESTERN LAND TREATMENT AREA CROPS AND APPLICATION RATES

To enable farmers to maintain the current practice of growing 30 to 40 percent corn, farming would be done in circular strips whenever the center-pivot irrigation rigs were used. Alternate strips of Reed Canary grass and corn would form concentric rings approximately 14 feet wide. This width would accommodate modern machinery and allow six rows of corn at 30-inch spacing, although the row spacing is not critical.

Within the irregular areas between the center-pivot irrigation rigs, solid-set irrigation systems would be used. It is contemplated that Reed Canary grass would be grown in these smaller irregular areas.

Several patterns of corn-to-grass crop rotation would be possible under the center-pivot irrigation rigs.

For example, the grass strips could be maintained for three to ten years, after which they would be plowed under and planted in corn. The old corn strips would be planted in grass during the preceding autumn. This method would require lower than average irrigation rates until approximately the first cutting, to allow new grass to become established. The reduction, however, would not significantly diminish the annual capacity of the land treatment area, since the alternation between corn and grass would be made for only 10% to 30% of the irrigation rigs each year.

Another method of crop rotation would be to plant Reed Canary grass over the entire area using a desiccant to retard growth of the grass in the corn strips from spring to early fall. The grass would reassert itself in the fall and become the grass strips in the following year. Corn would be planted in the spring, on the preceding year's grass strips after the desiccant was applied, resulting in a no-tillage type of farming.

One of the desiccants used would be Paraquat, which is non-selective when applied at very high rates. At lower rates it kills annual weeds and grasses while preventing growth of perennial grasses until later in the season by acting as a contact desiccant.

Paraquat is subject to very rapid and complete inactivation by the soil. Therefore, there is no danger of its moving with the drainage water. (Herbicide Handbook of the Weed Society of America, Second Edition, 1970). Low concentrations which might occur in runoff have very little effect on plant and animal life on land or in water. (Ecological Effects of Pesticides on Non-Target Species, published by the Executive Office of the President, June 1971).

Regrowth of the grass before harvest time could be advantageous in a wet fall, since heavy corn-harvesting equipment could operate in the fields. During the fall of 1972, some of the corn crop was lost due to the problem of soft ground making fields impassable.

Center-pivot irrigation rigs would apply the treated wastewater directly only on the grass strips at twice the average application rate, For the Cardington-Bennington soils in western Ohio on which an average application rate of 75 inches per year is proposed, the grass strips would receive 150 inches per year. The spray nozzles would produce droplets having low kinetic energy, which would limit the dispersion of soil aggregates upon impact. Grass cover would also prevent soil dispersion on these silty soils.

The center-pivot rigs would make three to four revolutions daily applying approximately 0.18 inches of water on each pass. This water would infiltrate long before the next rotation of the sprinkler.

On the area irrigated by the solid-set sprinklers, 75 inches of water per year would be applied uniformly over the surface. Applications can be scheduled as desired at a rate of approximately 0.25 inches per hour. Applications of 2.5 inches per week would require ten total hours of sprinkling at this rate. Applications on these lands could readily be increased to 120 inches per year or more, which provides a safety factor of significant proportions.

APPLICATION RATES FOR THE THREE SELECTED SOILS

The selection of an application rate for each soil was based on the parameters of infiltration rate, permeability, nutrient balance, and renovative capacity of the soil.

Infiltration Rate

Details of soil infiltration capacity are given in the Land Treatment Phase I Technical Appendix. This parameter may become the limiting condition for soils with a high silt content in the upper horizon, which is characteristic of both the Chili and Cardington-Bennington soils. Large drops of water on the bare soil have a tendency to disperse the soil structure, which reduces the infiltration capacity and forms a thin crust upon drying.

a. Chili soils have a silt content of approximately 60 percent in the upper two feet. Below this depth, the soil generally changes drastically to a sand and gravel layer where the silt content drops to about 18 percent as shown in Table II-I of the Land Treatment Technical Appendix. Deep plowing to a depth of 30 to 36 inches could overturn the soil profile, depositing the coarser soil on top. Considerable mixing would be likely to occur under these circumstances.

b. Cardington-Bennington soils in western Ohio have relatively high silt contents in the top layer, which gradually diminish with depth. Reed Canary grass used in conjunction with a solid-set irrigation system would avoid the soil dispersion effect of large droplets on bare soil. Similarly, the center-pivot irrigation rigs can be used successfully with alternate strips of corn and grass, as discussed above. The infiltration capacity of the Cardington-Bennington soil was the single most important constraint governing the selection of the farm management method. With a total grass crop, the average application rates could be increased to about 120 inches per year for optimum nitrogen balance.

c. Mahoning-Ellsworth soils have a lower silt content than the Chili or Cardington-Bennington soil associations, so that the infiltration rate is dependent not on surface conditions, but on the sub-surface permeability of the soil. The overland-flow/infiltration method of irrigation is proposed for the Mahoning-Ellsworth soils.

Permeability.

The permeability of a soil controls the rate at which percolating water can reach the tile drain system and the degree of aeration in the root zone. Detailed drainage analyses have indicated suitable tile spacings greater than those selected in this study. The analyses were based upon computations using standard agricultural engineering methods, and upon recent Ohio field tests made on similar soils.

The drain tile spacing in the Western Land Treatment Area is satisfactory for root aeration of both the corn and the Reed Canary grass proposed. See Land Treatment Phase II Appendix.

The permeability of the Cardington-Bennington soils varies from 0.63 to 2.0 inches per hour in the plow layer. Beneath this zone, the permeability decreases to 0.2 to 0.63 inches per hour.

For the Mahoning soils the overland-flow/infiltration method on Reed Canary grass was chosen. This method simulates the border method (overland flow) of releasing the water at the upper end of a ten-foot wide strip and allowing the water to flow by gravity towards the lower end. Any water remaining at the lower end is collected and released to the next lower battery of borders. For this method, 90 inches per year for municipal/industrial effluent and 150 inches for storm water were selected. The higher rate for storm water was used because of the considerably lower concentration of

nutrients and BOD. Permeability of these soils will permit complete infiltration of the wastewater through the soil zone, which will result in a double treatment.

The Chili soils are sufficiently permeable so that this parameter does not limit any reasonable application rate. For the upper two feet, the permeability varies from 2.0 to 6.3 inches per hour and increases to more than 12.0 inches per hour below the C-horizon. The rate of 60 inches per year was selected on the basis of nitrate leaching potential. This application rate is considered conservative, and higher application rates may be found reasonable after testing.

Nutrient Balance

The subject of nutrient balance is discussed in a separate subsection beginning on page III-13. Generally, the application rate is selected to provide enough nitrogen for optimum crop yields without losing excessive nitrates by leaching. An allowance should also be made for up to 40 to 50 percent nitrogen loss before plant uptake of nitrogen. Much of this nitrogen is volatilized. The percentage lost to the atmosphere will depend on the soil texture, temperature, moisture conditions and acidity.

Renovative Capacity

The renovative capacity is dependent upon the soil and plants. Too high an application rate would cause an excess of nitrogen to be carried into the drainage water. The amount would depend on the type of crop, soil texture, organic matter in the soil, and other factors. The selection of application rates equal to 60, 90 and 75 inches per year on the Chili, Mahoning and Cardington-Bennington soils, respectively, was based primarily on providing enough nitrogen to the crops for satisfactory yields while meeting the max-

imum O.C.E. levels for nitrogen as N of 4 mg/l.

Renovation of wastewater for other pollutants such as phosphorous and heavy metals is related more to the soil's capacity to store these elements, although plant uptake is important for phosphorous removal, especially that which is in the soluble forms.

The renovation of the wastewater for each of the farm management methods is discussed in detail in the Land Treatment Phase II Appendix. The return flow will be renovated to a degree meeting the 1985 effluent goals.

DRAINAGE

Drainage, both surface and subsurface, is of paramount importance to farmers in Ohio. Artificial drainage helps the farmer to get into the fields early in the spring and at harvest time during a wet fall and lessens the possibility of depressed yields resulting from a prolonged rainy period.

The Chili Association

This soil is relatively coarse having a permeability range from 2.0 to 6.3 inches per hour in the A and B horizons. Below this, the soil has sand and gravel texture with permeabilities in excess of 12 inches per hour. For an application rate of 60 inches per year, subsurface drainage would not be required on high ground, but could be limited to the low areas where the water table is high in the spring. For cost purposes, drains were assumed to be constructed at a depth of five and one-half feet and spaced 60 feet apart. Shallow wells may be preferable to subsurface drains, especially for reuse of the renovated effluent.

Cardington-Bennington Association in Western Ohio

This soil association requires subsurface drainage under present con-

ditions. The drains are placed approximately 36 inches deep at the top of the glacial till. The drain spacing recommended by the 1965 Ohio Drainage Guide is 50 to 75 feet for general crops. The permeability of the "A" horizon is from 0.63 to 2.0 inches per hour and diminishes to 0.2 to 0.63 inches per hour in the "B" and "C" horizons.

Two types of irrigation, the center-pivot and the solid-set systems, have been proposed for these soils. The large center-pivot irrigation rigs would be suitable for about 75 percent of the area, and the irregular areas remaining would be irrigated by the solid-set system. All of the irrigation would take place on Reed Canary grass.

Irrigation will cease during wet periods, corn planting and during harvesting periods. When irrigation is interrupted during the planting and harvesting seasons, the water table will tend to drop to the level of the drains at about 36 inches. When the irrigation rigs are operating full time, the phreatic line will fluctuate within a relatively narrow range between the ground surface and the drains.

The best estimate of the drain system flow-through rate comes from Schwab and Fouss. Their experimental data for soils with characteristics similar to the Mahoning soils, documented the performance of a system with a drain spacing of 40 feet. This drain system discharged, from a saturated profile, two inches per day. For a 20-foot spacing, as proposed for the Cardington-Bennington soils, the discharge from the drains should approximately double. Since the water is to be applied on only one-half of the surface area, eight inches per day, including rainfalls, would be the theoretical maximum application rate for the hydraulic capacity of the soil zone-drain tile system under saturated conditions. The proposed irrigation rate is approximately five inches per week on the grass strips. A drainage analysis is presented in

the Land Treatment Phase II Technical Appendix.

Mahoning Soils

The method of irrigation proposed for these soils is similar to the border system still used in the western states. The borders would be ten feet wide. Water would be released at the upper end and allowed to run overland through a grass coverto the lower end. All of the water will infiltrate through the soil column so that there will be no excess at the lower end.

The permeability of these soils is lower than that of the Cardington-Bennington soils, ranging from 0.2 to 0.63 inches per hour in the upper foot, and from 0.063 to 0.2 inches per hour in the next 18 to 24 inches. These permeabilities are identical to the Fulton soils on which Schwab and Fouss conducted their experiemnts. In this case, however, the water will be applied once a week at the rate of about two and one-half inches per week (90 inches per year) for municipal and industrial effluent, and about four inches per week (150 inches per year) for storm water. The application time will be governed by the infiltration rate and length of run.

CROPPING AND PROJECTED PRODUCTION

The crops currently grown in northern and western Ohio include corn, soybeans, wheat, oats and hay. In 1970 these crops represented approximately 32%, 33%, 13%, 7% and 15% of the harvest, respectively. On the Cardington-Bennington soils, by use of alternating strips of grass and corn, half of the area under the center-pivot system would be planted in corn. It is estimated that 75 percent of the area in the western Ohio land treatment site can be put under a center-pivot system which allows approximately 35 to 40 percent of the land to be planted in corn. The remainder would be in Reed Canary grass.

The overland-flow/infiltration method recommended for the Mahoning-Ellsworth soil association requires grass for the entire site. For convenience in estimating crop production, it has been assumed that the Chili soils will be 70 percent corn and 30 percent grass. With the above assumptions the values of the crops from the land treatment areas are shown in Table III-1.

TABLE III-1

SUMMARY OF CROPS, YIELDS AND ANNUAL GROSS INCOME
FOR 2020 FLOWS IN PLAN C

Soil Association	Crop	Acres(1)	Yield Amount	Yield Unit	Unit Price ($)	Gross Value ($/Acre)	Gross Total Value ($1000)
Chili	Corn	9,284	160	Bu/Ac	1.50	240.00	2,228
	Reed Canary-grass	4,000	4	T/Ac	50.00	200.00	800
Mahoning	Reed Canary-grass	6,280	4	T/Ac	50.00	200.00	1,256
Cardington-Bennington	Corn	41,300	200	Bu/Ac	1.50	300.00	12,390
	Reed Canary-grass	76,727	5	T/Ac	50.00	250.00	19,182
	TOTALS	137,591					35,856

(1) Does not include land irrigated by separate storm runoff treatment systems.

The yields for the crops shown above are based on recommended farm managment practices. Nutrients will be provided by the wastewater. The unit prices are based on current (April, 1973) quotes which are now in an upward trend and higher than the depressed prices received by the farmers a year ago. The gross annual return per acre amounts to $262, resulting in a net profit of about $200 per acre to the farmer, disregarding costs of land treatment components. The net profit also includes the fertilizer value in the wastewater effluent which is provided at no cost to the farmer, but has a value of approximately $60 per acre. Without the amount of nutrients provided in the sewage

effluent, the yields would generally be lower since most Ohio farmers would not spend more than $40 per acre on commercial fertilizer. Furthermore, commercial fertilizers in Ohio are applied once or twice a year, rather than in steady daily or weekly doses, which would not provide the nutrients as efficiently as would the steady applications. Sewage effluent also contains other nutrients in readily available form which are not generally provided in commercial fertilizers unless a critical deficiency has been indicated by a county extension agent.

In the future, wastewater renovation ponds and reservoirs may provide a direct source of cattle feed. The University of California at Davis has developed and tested a pilot plant which removes algae from these basins and converts it to a high-protein cattle food. Analyses have shown that the protein content is comparable to mature alfalfa hay and high quality oat hay.

SALINITY CONTROL

In arid areas of the world, a hazard of irrigation is the salinization or alkalization of the soil. This hazard is related to the quality of irrigation water and to subsurface drainage.

Water quality for irrigation depends on (1) total dissolved solids concentration, (2) the proportion of sodium to other cations, and (3) the presence of special toxic ions such as borate or, for some crops, possibly chloride, sodium, or bicarbonate. Unfortunately, usual chemical analyses of the Cleveland shoreline plants' effluent does not include information on elements such as sodium, potassium, calcium and magnesium. On February 23, 1973, a sample of the Cleveland Southerly plant was analyzed for the pertinent elements with the following results:

Calcium	92 mg/l
Sodium	150 mg/l
Magnesium	4.1 mg/l
Potassium	82 mg/l
Total Dissolved Solids	752 mg/liter

Sodium chloride and calcium chloride are used on the streets to melt the snow and ice in Cleveland. The snow was melting on February 23, 1973. The calcium, sodium and total dissolved solids in this sample are higher than would be normal.

The U.S. Salinity Laboratory uses the sodium adsorption ratio (SAR) and the electrical conductivity of the water as criteria to evaluate the sodium hazards of irrigation water. For this particular sample, the electrical conductivity and sodium adsorption ratio is equal to 1175 micromhos/cm x 10^6 and 4.2, respectively. A diagram used by the U.S. Salinity Laboratory for classifying irrigation water based on the above two parameters would place this sample into the better quality side of Class C3-S1. As far as sodium is concerned, the water could be used on almost all soils with little danger of accumulation of harmful amounts of exchangeable sodium. In an arid climate, where conservation of water is necessary, there would be little surplus water applied which would leach excess salts downward. With such practices in mind, the U. S. Salinity Laboratory classified this water as a medium salinity water, which can be used on soils of medium permeability. They also recommend that plants of moderate salt tolerance should be selected and that special salinity control management should be used. At the proposed irrigation application rates of 60 to 90 inches per year, however, salts would be leached to the drainage system, so that they would not tend to accumulate. In the moderately humid climate of Ohio, at high application rates and with the proposed drainage tile spacing of 20 feet the leaching would constitute

a special management control.

It has been concluded that the Cleveland area wastewater is quite suitable for irrigation from the standpoint of salinity and the SAR of the soil.

An advantageous aspect of the land treatment system in Plan C relative to total dissolved solids is the fact that combining storm runoff with municipal and industrial wastewater in the Western Land Treatment Area will reduce the TDS concentration of the municipal/industrial wastewater and of the effluent discharged to natural watercourses.

NUTRIENTS

Sewage effluent from an activated sludge plant, or an aerated lagoon, is rich in nutrients required for plant growth. Typical sewage effluent in the Study Area contains macro-nutrients such as nitrogen, phosphorous, potassium, calcium, magnesium and sulphur; and micro-nutrients such as iron, copper and zinc.

When sewage effluent is utilized in a land treatment program and applied at a rate of 60 inches or more a year, most of these nutrients (with the possible exception of nitrogen) exceed plant requirements. This excess is usually captured by soil adsorption onto clays, cation exchange or attachment to organic matter. In areas with heavy rainfall and good soil drainage, some calcium, magnesium and potassium will migrate with the soil solution into the ground water aquifer or into subsurface drains.

The nutrients, nitrogen, phosphorous, and potassium are considered primary nutrients for plant growth and are discussed below.

Nitrogen

More laboratory and field work has been done on nitrogen than on any other plant nutrient. Despite this research, conclusive statements about the

behavior of nitrogen in the soil are scarce. Nitrogen is mobile and can be transformed from the solid to the liquid or the gaseous state under the proper conditions. The soil's acidity, temperature, and moisture content, and the availability of oxygen, are the most important variables which influence the behaviour of the element.

The concentration of nitrogen in effluent from a standard activated sludge plant is approximately 20 mg/l. Typically, 80 to 90 percent of this nitrogen is in the form of ammonium ions. Most of the remainder is in the organic form with a small amount of nitrate and nitrite ions. Wastewater which has received treatment in an aerated lagoon system may contain more nitrogen in the form of nitrates than wastewater treated in an activated sludge plant.

Nitrogen uptake by plants reaches a peak during the growing season. In warm, moist weather nitrification of the ammonium ion also proceeds rapidly. Most plants require some of the nitrogen to be in the form of nitrates, although the roots can readily accept the ammonium ion and sometimes prefer it.

When the soil temperature is below 50°F, nitrification takes place much more slowly. Nitrogen is then stored in the form of ammonia and held by the soil colloids. Experiments have been conducted in which anhydrous ammonia fertilizer is applied to agricultural land for several years. After this period, succeeding applications do not increase the crop yields, as large amounts of nitrogen, stored in the form of the ammonium ion, are available in the soil profile.

In a sandy, coarse-textured soil, excess nitrates will eventually migrate with the ground water into the subsurface drainage system and pass into the creeks and rivers.

Nitrate leaching may occur in fine-textured soils but the extent of the

leaching is limited by the soil's basic properties. The abundant clay colloids tend to store the nitrogen as ammonia and to release it according to the plant demand. In addition, the nitrates migrate more slowly through a fine-textured soil, giving root fibers more time to absorb these ions. When sewage effluent is applied to fine-textured soils at a rate of two to four inches per week, alternating aerobic and anaerobic conditions result in a nitrification-denitrification process. During these reversals, nitrogen will be lost to the atmosphere in the form of nitrogen gas (N_2). This loss may equal up to fifty percent of the nitrogen applied.

Application Rates and Nitrogen Balance

To ensure the proper nitrogen balance in soils receiving applications of sewage effluent, the application rates were calculated separately for each soil type. In the coarse-textured soils of the Cuyahoga Basin where there is some risk of nitrate leaching to the ground water, application rates have been limited to 60 inches per year. On the tighter Cardington-Bennington and Mahoning-Ellsworth soils, the application rates have been set at 75 and 90 inches per year, respectively.

The effluent applied on the Cardington-Bennington soils in western Ohio will be a mixture of municipal/industrial wastewater and storm runoff, with nitrogen concentrations of 19.7 and 2.2 mg/l respectively. The mixture of 83 percent M & I wastewater, and 17 percent storm runoff will result in an effluent containing nitrogen at approximately 16.4 mg/l, as stated in the Phase II Land Treatment Report. At an average application rate of 75 inches per year, the average nitrogen application would amount to 278 lbs/acre/year. The direct application rate of 150 inches per year on one-half of the area irrigated by center-pivot rigs would result in a nitrogen application of 556 lbs/acre/year to the grass strips only. Volatilization losses of nitrogen

will range up to 50 percent of the total amount applied. Assuming a 40% volatilization loss of 225 lbs/acre/year from the Cardington-Bennington soils planted in strips of Reed Canary grass, 331 pounds of nitrogen would be available for crop uptake annually. Assuming a harvest of 4.5 tons of Reed Canary grass per acre per year and a nitrogen content of 62 lbs. per ton, the crop uptake would be 279 lbs/acre/year leaving a balance of 52 lbs/acre/year.

There are three possibilities for the disposition of the balance: leaching, uptake by the adjacent corn rows and storage in the soil. It is estimated that the adjacent corn rows would utilize at least 30 pounds of the excess nitrogen from the irrigated grass strips. Neglecting storage of nitrogen in the soil, approximately 22 lbs. of nitrogen per acre per year would migrate through the soil zone to be carried in the return flow. However, this represents an average migration of 11 lbs/acre/year from the gross acreage under irrigation by the center-pivot rigs.

Based upon the effluent criterion for nitrogen of 4.0 mg/l for Level II Standards, the permissible leaching of nitrogen with the return flow should be limited to the range of 50 - 70 lbs/acre/year or approximately 120 lbs/acre/year from the directly-irrigated grass portion of the center-pivot rig acreage.

If only Reed Canary grass were grown, as described in the Phase II Report, average application rates should be raised to 120 inches/year for optimum balance between high-protein grass and nitrogen application.

That portion of the Cardington-Bennington soil irrigated by solid-set sprinklers (25 percent) would receive a nitrogen application of only 278 lbs/acre/year. The optimum nitrogen application for Reed Canary grass is approximately 445 lbs/acre/year. Therefore, a substantial safety factor exists

for readjusting the application rates between areas irrigated by the center-pivot rigs and the solid-set equipment. The amount of water applied by the solid-set equipment might be increased to 120 inches per year, permitting a reduction in the application rate of the center-pivot rigs.

On Chili soils within the Three Rivers Watershed, where an irrigation rate of 60 inches/year of municipal/industrial effluent has been proposed, the annual nitrogen application would be 268 lbs/acre. Volatilization from this relatively coarse-grained soil would account for a lower percentage of the nitrogen than would volatilization from the Cardington-Bennington soils. Assuming a nitrogen loss of 25 percent of 67 lbs/acre/year through volatilization from the Chili soils, an annual balance of 201 lbs/acre would be available for crop uptake or leaching. The rate of nitrogen uptake would be 160 lbs/acre/year for corn and significantly more for Reed Canary grass, leaving a maxiumum of 41 lbs/acre/year for leaching and storage in the soil.

The application of 90 inches/year to the fine-grained Mahoning soils, using the overland-flow/infiltration method would result in a nitrogen application of 400 lbs/acre/year. It is anticipated that crop uptake by the Reed Canary grass and the volatilization of nitrogen would account for essentially the full amount of nitrogen applied.

Phosphorous Loading

According to the Phase I Report by Havens & Emerson, the phosphate contents of municipal/industrial wastewater and storm runoff are 10.2 mg/l and 2.2 mg/l, respectively. At the Western Land Treatment Area, the combination of municipal/industrial wastewater and storm runoff would result in an approximate phosphorous concentration of 8.3 mg/l, as stated in the Phase II Land Treatment Report. With an application rate of 75 inches per year the phosphorous loading would amount to 145 pounds per acre per year. This repre-

sents approximately three times as much phosphorous as would normally be applied in commercial fertilizers for good yields on typical soils. The excess phosphorous would react chemically with the aluminum and iron ions abundant in the Cardington-Bennington soils. This process would proceed rapidly and the phosphorous would not easily be released. Calcium ions, provided by lime applications, would combine chemically with phosphorous to form a tightly held precipitate.

These processes would provide a high level of removal at the Western Land Treatment Area. The treatment will meet the Level II Standards easily and may satisfy the more stringent O.C.E. Goals of 0.10 mg/l for phosphorous as PO_4. Treatment on the Mahoning-Ellsworth soils utilizing the overland-flow/infiltration method should achieve a similar level of removal. On the more coarsely textured Chili soils, the application rates have been limited to 60 inches per year to meet the Level II Standards.

Potassium Application

Potassium is a primary crop nutrient. The Ohio Agronomy Guide suggests an application rate of 250 pounds/acre of potassium as K for best crop yields. This crop requirement would be satisfied by a concentration of 15 mg/l in effluent applied at a rate of 75 inches per year. The potassium content of wastewater from the Study Area has not been documented by this study, but certainly exceeds the crop requirement. Excess potassium would be leached to the drainage system. The Level II water quality standards do not set a limitation on the concentration of potassium in treated effluent, since it is not considered a harmful pollutant.

RECYCLED NUTRIENTS

Nutrients contained in wastewater from the Cleveland-Akron Metropolitan

and Three Rivers Watershed Area represent a substantial resource, which will become more valuable as the elements become scarce and the cost and energy required to process them escalate. Table III-2 presents the amounts of nitrogen, phosphorous and potassium contained in Study Area wastewater, storm runoff and sludge, summarized according to treatment facilities proposed in Plan C for the year 2020. The value of these nutrients was based on 1972 unit costs of 15 cents per pound for nitrogen, ten cents per pound for phosphorous, and five cents per pound for the amount of potassium recommended for crops. The net totals for the value of phosphorous were halved, since the total amount applied to the land would be twice that required for top yields.

The estimated value of the reclaimable nutrients is $9,450,000 for the year 2020. (Approximately $705,000 worth of nutrients from the water-based Akron plant are not included.) The additional value of the secondary nutrients sulfur, calcium and magnesium, and the mirco-nutrients contained in the effluent and sludge has not been estimated. However, the value of these nutrients may increase considerably as the costs to process similar fertilizers escalate.

TABLE III-2

SUMMARY OF NUTRIENTS IN SEWAGE EFFLUENT, STORMWATER AND SLUDGE

(Based on 2020 Flows in Plan C)

	NITROGEN		PHOSPHOROUS		POTASSIUM	
	Million Lbs.	$1000	Million Lbs.	$1000	Million Lbs.	$1000
WESTERN OHIO LAND TREATMENT AREA						
Sewage Effluent	32.9	$4800	17.3	$ 860	24.4	$1220
Storm Runoff	.2	30	.1	5	.2	10
Sludge	2.9	435	1.7	85	.9	45
Subtotal	36.0	$5265	19.1	$ 950	34.5	$1275
IN-BASIN TREATMENT						
Sewage Effluent	5.6	$ 840	2.9	$ 145	4.3	$ 215
Storm Runoff	1.5	225	.3	15	1.3	65
Sludge	0.5	75	0.3	15	0.1	5
Subtotal	7.6	$1140	3.5	$ 175	7.1	$ 285
AKRON TREATMENT PLANT						
Sewage Effluent *	9.0	$ 135	4.6	$ 230	6.8	$ 340
Sludge	1.6	240	1.6	80	0.8	40
Subtotal	10.6	$ 375	6.2	$ 310	9.9	$ 380
TOTAL	54.2	$6780	28.8	$1435	51.5	$1940

* These nutrients would be discharged to the Cuyahoga River and would not be reclaimable.

HEAVY METALS

Sources of Heavy Metals

The metals in urban wastewater are generated by industry, domestic wastes and storm runoff. The industrial sources have been studied by AWARE and are discussed in detail in their Industrial Wastes Phase I Report. Five possible levels of industrial pretreatment were defined and costed by AWARE. These alternatives varied substantially in cost, depending upon their removal criteria. Alternative 3 provided for the most complete in-house industrial treatment and was the most expensive alternative, with a present worth cost, at seven percent interest, of $1,013.8 million. Alternative 5A, which called for a lower degree of industrial pretreatment with removal completed by land treatment, had a present worth of $518.7 million (at seven percent interest), or a present worth approximately half that of Alternative 3. The cost of industrial pretreatment is thus in the same general range as that of the total municipal/industrial treatment system, which is approximately $1,400 million.

The U.S. Army Corps of Engineers has directed that all three wastewater management plans include Alternative 3, with a high removal of heavy metals; therefore, the discussion of confined disposal of heavy metals from industry in the soil zone using land treatment is intended for general information purposes only.

Section X of the Land Treatment Phase I Report provides a discussion concerning the potential load of heavy metals from industry and their accumulation in the soil. Specific reference is made to Table X-8 which tabulated long-term concentrations of some typical heavy metals, assuming no industrial pretreatment to remove them. Furthermore, these metal loadings assume no major future change in the present philosophy of use and conservation of natural resources by industry.

Stormwater contributes heavy metals to the total treatment load as it cleanses the streets, parking lots, lawns, driveways, raw material stockpiles, and open industrial areas. The stormwater carries litter, particulate exhaust emissions, hydrocarbons, heavy metals, toxic compounds, fertilizers, and pesticides.*

The heavy metals washed into receiving waters during a 0.5 inch/hour rainstorm from a typical urban area of one (1) million people were estimated by Condon:

TABLE III-3

STORM RUNOFF FLUSHING OF HEAVY METALS

Elements	Runoff Load in Lbs/Hours
Zinc	2,600
Copper	800
Lead	2,300
Nickel	200
Mercury	290

The domestic contribution of heavy metals is not well known because nearly all municipal effluent contains industrial wastes to some extent. However, a review of the lables of typical household products such as cleaners, breakfast foods, vitamin pills, toothpaste and common medicines indicates that a steady stream of heavy metals is contributed by domestic sewage.

Heavy Metal Uptake by Crops

Typical quantities of some heavy metals found in common crop plants are presented in Table III-4. Since general agricultural conditions cause tremendous variability in uptake, the figures given represent values near the middle of the range reported. (Allaway, 1968, and Chapman, 1966). The average values given in the final column were used to calculate the amounts of heavy metals removed from the soil by typical plant growth, as shown in Table III-5. The annual heavy metals uptake was calculated based upon an average removal of

* Condon, Francis J. "Treatment of Urban Runoff", APWA Reporter.

TABLE III-4

CONTENT OF SOME HEAVY METALS IN TYPICAL CROPS*

(Ppm in dry plant material)

Element	Alfalfa	Barley	Beans	Cabbage	Carrot	Clover	Coffee	Corn	Soybean	Tomatoes	Plant Matter Typical Values
Cadmium											0.5
Chromium		1						0.5			0.8
Copper		10				10	10	9		20	10
Iron								100	120	107	110
Lead	5	1	2	0.5	2.6	6				5	5
Nickel	2	4		3	1	1	0.4	0.14	4		2
Silver	0.3					0.5	0.02				0.3
Zinc	30					39	7	50		13	30

*Values near the middle of the range reported by Allaway (1968) and Chapman (1966). See references No. 1 and 2.

TABLE III-5

REMOVAL OF TYPICAL HEAVY METALS BY PLANTS

Element	Annual Loading Rate (Lbs/Acre) (1)	Additional Annual Concentration in Soil from Irrigation Water (ppm/Acre-foot Slice)	Concentration of Elements After 100 Years (ppm/Acre-foot Slice) (2)	Normal Plant Content (ppm) (3)	Annual Plant Removal (Lbs/Acre) (4)	Percent of Annual Addition Removed By Plant	Normal Soil Content (ppm)
Cadmium	0.075	0.019	1.9	0.5	0.003	4.0	.01 - 7
Chromium	3.41	0.85	85	0.8	0.0048	1.4	5 - 3,000
Copper	2.12	0.53	53	10	0.06	2.8	2 - 180
Iron	16.4	4.1	410	110	0.66	4.0	50,000
Lead	0.066	0.016	1.6	5	0.03	45	2 - 200
Nickel	2.12	0.53	53	2	0.012	0.57	10 - 1,000
Silver	0.0115	0.0029	0.29	0.3	0.0018	15.6	1 - 5
Zinc	2.63	0.66	66	30	0.18	6.8	10 - 300

(1) Values taken from Table X-8, Wright-McLaughlin Land Treatment Phase I Report.
(2) These values are based on an irrigation rate of 75 inches per year.
(3) Values derived from preceding Table III-4.
(4) These values are based on removal of 6,000 pounds of dry plant material per acre, and the normal plant content.

three tons of dry plant material per acre. This removal figure is too high for some plants and too low for others, but it is sufficiently accurate to illustrate the point that a fairly low percentage of the heavy metals added each year would be removed with the crops. As indicated in Column 6 of Table III-5, the percentage removal would range from less than 1 to about 16 percent.

The capacity of soil to adsorb heavy metal ions varies widely, but is at least 20,000 lbs/acre-foot slice. Of the elements treated in this report, exclusive of iron, soils contain about 2,000 - 2,500 lbs/acre-foot slice. The amount of these elements added each year with 75 inches of effluent, would be about 20 - 40 lbs/acre-foot slice (exclusive of iron). This is a fairly insignificant amount compared to the total adsorption capacity of the soil. It also represents a small percentage of the natural "background" concentration of these elements in soils.

The total amount of a particular heavy metal present in the soil may not be very meaningful in terms of plant growth, plant toxicity or leaching. It is the solubility of the element that is most critical and this information is difficult to isolate due to the many factors, such as soil pH, degree of soil aeration, texture and kind of clay mineral, organic matter, temperature and moisture, which cause variations. The most critical factor is soil pH, because the solubility of heavy metals is closely dependent upon it. Generally, as pH increases, solubility decreases.

A brief discussion of some important heavy metals is given below:

Cadmium. The chemistry of cadmium is somewhat similar to zinc. It would take more than 100 years of adding .075 lbs/acre/year to reach the upper limit of the normal range of cadmium in soils. John et al. (1972) showed that 90 lbs/acre of cadmium added to the soil surface over several years did not move below

the 4-inch level in the soil profile. They also showed little increase in cadmium uptake in oats. Traynor and Knezek (1972) found some increase in uptake in corn with cadmium application to the soil. Unless soluble and mobile complexes with low molecular weight organic compounds are formed, there should be little danger of leaching in high pH soils (Murrmann and Koutz, 1972).

Chromium. Although the three pounds of chromium per acre per year to be added to soil through land treatment of effluent is relatively high compared to some of the other heavy metals, it has a low solubility and for several years this addition should be well within the normal range in soils. Knezek (1973) indicated that soils have a high capacity to fix chromium. Pratt (1966) found no appreciable accumulation of chromium in plants in cases where chromium toxicity has been thought to exist. However, Turner and Rust (1971) found a chromium toxicity in soybeans when 10 lbs. chromium per acre was added, although the concentration of chromium in the plants was not reported. Soane and Saunder (1959) showed that chromium added to sand cultures at concentrations of 10 ppm caused toxicity to tobacco plants; however, they did not prove that a high chromium content in the serpentine soils was the cause of infertility.

Copper. Ellis and Knezek (1972) showed that copper would be bound to organic and clay complexes near the soil surface. Reuther and Labanauskas (1966) reviewed the chemistry and toxicity of copper and indicated that it should cause no plant toxicity problems. Mitchell (1964) showed that there would be a minimal leaching of organic complexes containing copper into drainage waters. With the small amount of copper added each year in effluent there should be few if any problems for many years, as long as the pH of the soil is maintained near 7.0.

Iron. Relatively large quantities of iron compared to other heavy metals will be added in the effluent, but compared to the total of 50 tons or more per acre-foot slice in soil already, it is a minute amount. Since the added iron will be fixed rapidly (Mitchell, 1962), and since iron is seldom toxic to plants grown in natural soils (Wallahan, 1966), little if any problem should result from the effluent addition to soils of high pH. The major potential problem could be interaction with the uptake of zinc and manganese, if the pH of the soil were to drop. (Mitchell, 1964; Sauchelli, 1969; Wallahan, 1966).

Lead. Plants can accumulate high concentrations of lead (64 - 196 lbs/acre, according to Cox and Rains, 1972) although it is not known to be essential for animal or plant growth. Much of the lead from sewage treatment plants remains with the sludge, so that the effluent has a low concentration of this element. (Lead solubility is low at pH of 7.0, so leaching should present little problem.) Plants will die of lead toxicity before the concentration reaches levels high enough to be toxic to animals (Allaway, 1968). Solution culture with lead concentrations up to 200 ppm had no depressing effect on apples and grapes (Childers, 1941). Similar results with orange seedlings were found in California (Vanselow and Bradford, 1960). However, Wilkins (1957) found that lead concentrations of 10, 30, and 100 ppm in solution cultures, measureably retarded, markedly retarded and stopped growth respectively of fescue plants.

Nickel. Nickel is not known to be essential for plant growth but is taken up by plants in concentrations of 0.5 to 150 ppm. Two ppm of nickel is quite normal. A middle-of-the-range concentration in soils would be 100 ppm (Swaine, 1955), most of which is not soluble at any given time. The amount of soluble nickel approaches 1 ppm (Vanselow, 1966). In all but serpentine and basic igneous rock-derived soils, nickel toxicity should not be a serious problem.

Silver. Little is known about silver in soils, except that it occurs almost universally but only in minute amounts. Seldom does it exceed 1 ppm (Vanselow, 1966; Rogers et al., 1939; Swaine, 1951). It has been reported in plant tissue in amounts of less than 0.01 and no higher than 1.3 ppm in the dry matter. The occurrence of toxic amounts of silver is quite unlikely because of its extremely low solubility. Little leaching and movement through the soil profile should occur.

Zinc. Although zinc additions may be high from some effluents, comparable quantities are added as a fertilizer on field beans and corn in Michigan (Virande et al., 1967) with beneficial effects. Melton, et al. (1970) indicates that there is little danger of leaching or toxicity from zinc added with effluent, unless a zinc-sensitive plant is grown. Allaway (1968) indicated that some animal feeds are deficient in zinc, so additional zinc could be beneficial to animals. Zinc is needed at a concentration of 8 - 15 ppm in the forage dry matter. Animals require about 10 - 40 ppm zinc in the diet. At 200 ppm of the dry matter zinc is toxic.

An unpublished work of Sabey and Hart (1973) indicated that there was a build-up of extractable zinc, copper, iron and manganese on an irrigated sandy loam in the zone of incorporation of sewage sludge. No downward movement of these elements occurred during the first year after application.

The elements in Table III-IV should pose no serious threat to the groundwater or to plants growing on medium to fine-textured soils if the pH of the soil is maintained near 7.0. If however, the pH of the soil decreased to below 6.0, there is a possibility of increasing solubility of several of the elements, therefore increasing the likelihood of groundwater pollution and plant toxicity.

Heavy Metal Management

Maintenance of a sufficiently high pH (equal to 6.0 or more) in soils

receiving heavy metals would be an important part of land management unless monitoring demonstrated that somewhat increased solubilization of the heavy metals at lower pH values was not a hazard. Maintaining the pH at this level should pose no problem for agriculturalists, as good farm management generally dictates the use of lime to raise the pH to approximately 6.5. Lime applications are common on Ohio soils.

The Ohio 1972-1973 Agronomy Guide, Bulletin 472, published by the Cooperative Extension Service of Ohio State University, reported that lime applications on acid soils often return $6.00 to $9.00 for every dollar invested. According to this bulletin, approximately ten tons per acre would be required to increase the present soil pH of about 5.5 to a level of 6.5. Subsequent annual lime applications of about three tons per acre per year may be required to maintain the pH at about the 6.5 level.

It is clear that the possibility of toxicity to plants is greatest with an acid soil (pH less than approximately 6.0).

Field tests conducted at the University of Illinois have shown the feasibility of managing heavy metals on agricultural land. Should monitoring indicate an undesirable rate of accumulation for a particular heavy metal, management steps might include reduction of that metal at the source, incorporation of special removal processes at the secondary treatment stage, recycling of the element by industry, and rotation or substitution of crops.

SECTION IV

COSTS

All three plans are designed to meet the same Level 2 effluent standards; thus the costs may be compared equally. No cost credit is given to any plan for special benefits which may be unique to that plan.

The study period begins on January 1, 1972, and ends on December 31, 2019. At the end of the period, most of the components will have a residual value which is accounted for in the present worth comparisons. All capital expenditures are considered to be made at the beginning of the year in which the item is constructed. Operation and maintenance costs are evaluated as if spent at the end of the year and coincide with the amortized annual capital repayments.

Present worth computations have been made at discount rates of 5-3/8, 7 and 10 percent. These costs are summarized in Tables V-1 through V-6 of the Formulation Report. Annual costs or total annual costs are the sum of the operation and maintenance costs and the annual capital costs. These costs are summarized in Tables V-7, through V-12, of the Formulation Report at the three interest rates.

COST REVISIONS AND REFINEMENTS

The capital and the annual operation and maintenance costs for the land treatment components are presented in the summary of unit costs entitled "Cost Estimation Methodology and Unit Costs" as revised October 6, 1972. During the Phase III portion of the work, refinements and revisions were made to the unit cost of the following items:

1. Temporary Pumps. Capital costs were derived from Curve E (Phase II Report) and decreased 25 percent because of their temporary nature. The operation and maintenance costs were calculated according to previously established unit costs.

2. The mined storage constitutes a partial displacement of the storage previously costed for the concrete detention basins in the Phase II work. The capital costs for mined storage were estimated at $15 per cubic yard. The operation and maintenance costs were estimated to be 0.5 percent of the capital costs.

3. Miscellaneous capital costs were calculated as follows:

   .10 x Capital cost of aerated lagoons

   \+ .09 x Capital cost of land purchase and preparation

   \+ .05 x Capital cost of irrigation system

   \+ .05 x Capital cost of drainage system

   The first two items represent additions to the Phase II Capital Costs, which included administration, laboratory and monitoring facilities. The extra cost for aerated lagoons is to allow for possible channel realignment, fencing and piping. The extra nine percent for land purchase and preparation allows for about 20 percent land which must be purchased but cannot be readily used for land treatment. This would include items such as roads, buffer strips along streams, trees which would not be uprooted and other obstructions.

   The miscellaneous operation and maintenance costs are estimated to be five percent of the capital costs.

4. Shafts and Tunnels - Aeration. A capital cost for aeration of $17,000,000

was added for the tunnel construction costs of these units at ten-mile intervals.

The operation and maintenance cost for aeration was estimated to be $4 per MG.

5. Sludge Management. For Plans A, B and C, sludge application to agricultural or strip-mined land is accomplished in various ways. The time-phasing for these various methods for each plan is summarized in Tables IV-10, IV-11 and IV-12 of the Formulation Final Report. The various methods costed for strip-mine and agricultural sludge disposal are enumerated below.

   a. Use of Existing Pipeline to Strip-Mined Land prior to 1990.

      The capital costs include construction of pump station, rehabilitation of pipeline, construction of sludge lagoons, application appurtenances and supporting equipment.

      The operation and maintenance costs include power, maintenance of the pipeline, lagoons, application and labor costs. This amounted to between $18 and $20 per dry ton, depending on amount generated.

   b. Vacuum Filtered Sludge Trucked to Agricultural Land.

      The capital costs include the cost of trucks and holding tanks at terminal points.

      The operation and maintenance costs amount to a trucking cost of $1/ton-mile plus $40 to $50 per dry ton for the cost of spreading and working the sludge into the soil and paying the farmer to take the sludge.

c. New Pipeline to Strip Mines after 1990.

The capital costs include the cost of a new pipeline, pump stations, sludge holding lagoons, distribution piping, giant sprinklers and other appurtenances.

The operation and maintenance costs include the operation and maintenance of the above facilities, and power and labor costs. The total O & M cost amounts to $3.50 per dry ton.

d. Digested Liquid Sludge to Agricultural Land by Pipeline or Truck.

The capital costs include the cost of pipeline (if applicable), pumps, sludge holding tanks, sludge hauling trucks, spreading equipment and the cost of land.

The operation and maintenance costs include the operation and maintenance of the above equipment and power costs. The cost per dry ton decreases with output varying from $45 per ton in the early years to $35 per ton in 2020.

e. Liquid Sludge from Aerated Lagoons to Agricultural Land.

The capital costs include the costs of pumps, pipeline, vacuum system, spreading and land purchase.

The operation and maintenance costs consist primarily of the cost of maintenance of the above system, pumping costs, and labor. They vary from $10 to $20 per dry ton, depending on the size of the plant.

The Cost Appendix at the end of this report contains a complete display of the costs developed for Plan C.

SECTION V

EARLY ACTION IMPLEMENTATION

The need to establish present base mark conditions of water resources, and to inventory historic trends, is a key factor in this wastewater management plan.

Early-action programs should be initiated to produce data before the first major phase of construction. The objectives would be to provide experience for refining and optimizing designs and for making future decisions concerning the wastewater management system. Firm data on the costs and effectiveness of wastewater management techniques will require thorough monitoring programs to establish baseline environmental conditions and to record changes. Early-action programs will also demonstrate the practicality and benefits of the wastewater treatment systems and facilitate public review and participation. Suggested projects are summarized below:

1. Urban Stormwater Runoff Treatment Plants

   Land-based treatment of runoff from a separately-sewered, moderately-populated area not in a metropolitan urban environment (a sub-urban residential area such as a smaller outlying city in rural surroundings) -- earthen basin storage -- quantity and quality monitoring for Level 2 treatment.

2. Final Municipal Wastewater Treatment

   Land Treatment - (1) at an in-basin site using the overland flow/infiltration method -- (2) at an in-basin site using the spray irrigation method on Chili Soils -- (3) at a site in the Western Land Treatment Area using the center pivot rig

spray irrigation method on Cardington-Bennington Soils - with various land management techniques.

3. Storm Runoff Reduction by Urban Drainage Management

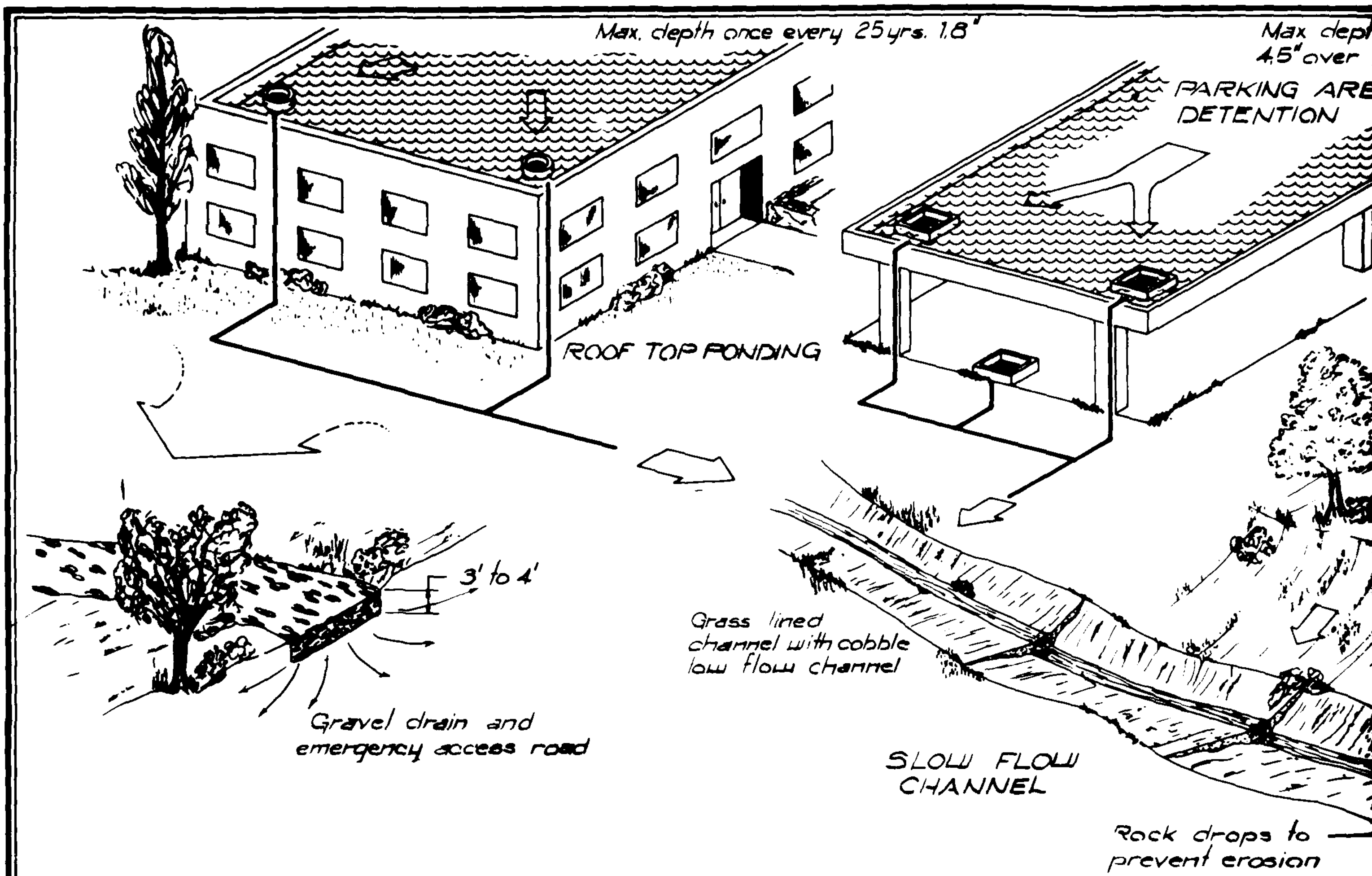
Provide storm drains, on-site storage, parking-lot storage, roof-top storage, and site work designed for maximum infiltration -- demonstrate techniques to reduce runoff -- sedimentation control practices to be demonstrated -- Planned Unit Development Concept applied to demonstration site -- use a commercial building block in a major city -- use open space in a major city suburb. See Figure V-1.

4. Sludge Handling

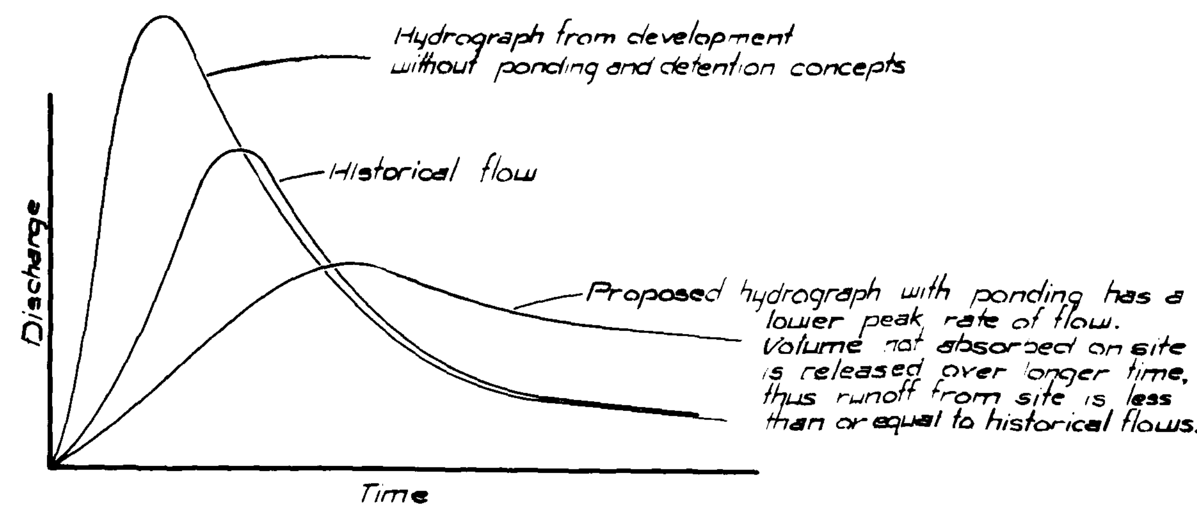
Show various ways to handle sludge -- apply to agricultural land, strip-mined land, and sanitary landfill -- monitor leacheate and surface runoff for loss of metals, salts, nutrients, and viruses -- compare crop yields and physical characteristics using conditioned soil with crops from non-conditioned soil -- study sludge application techniques, including injection and costs -- study problems posed by wintertime conditions -- use a mixed municipal-industrial sludge to measure heavy metal disposal capabilities of soil in agricultural land area -- demonstrate reclamation potential in strip-mined lands and other sterile areas.

5. Water Quality and Quantity Monitoring System

Master system for entire Three Rivers Basin Study Area -- computerized control center for water intelligence.

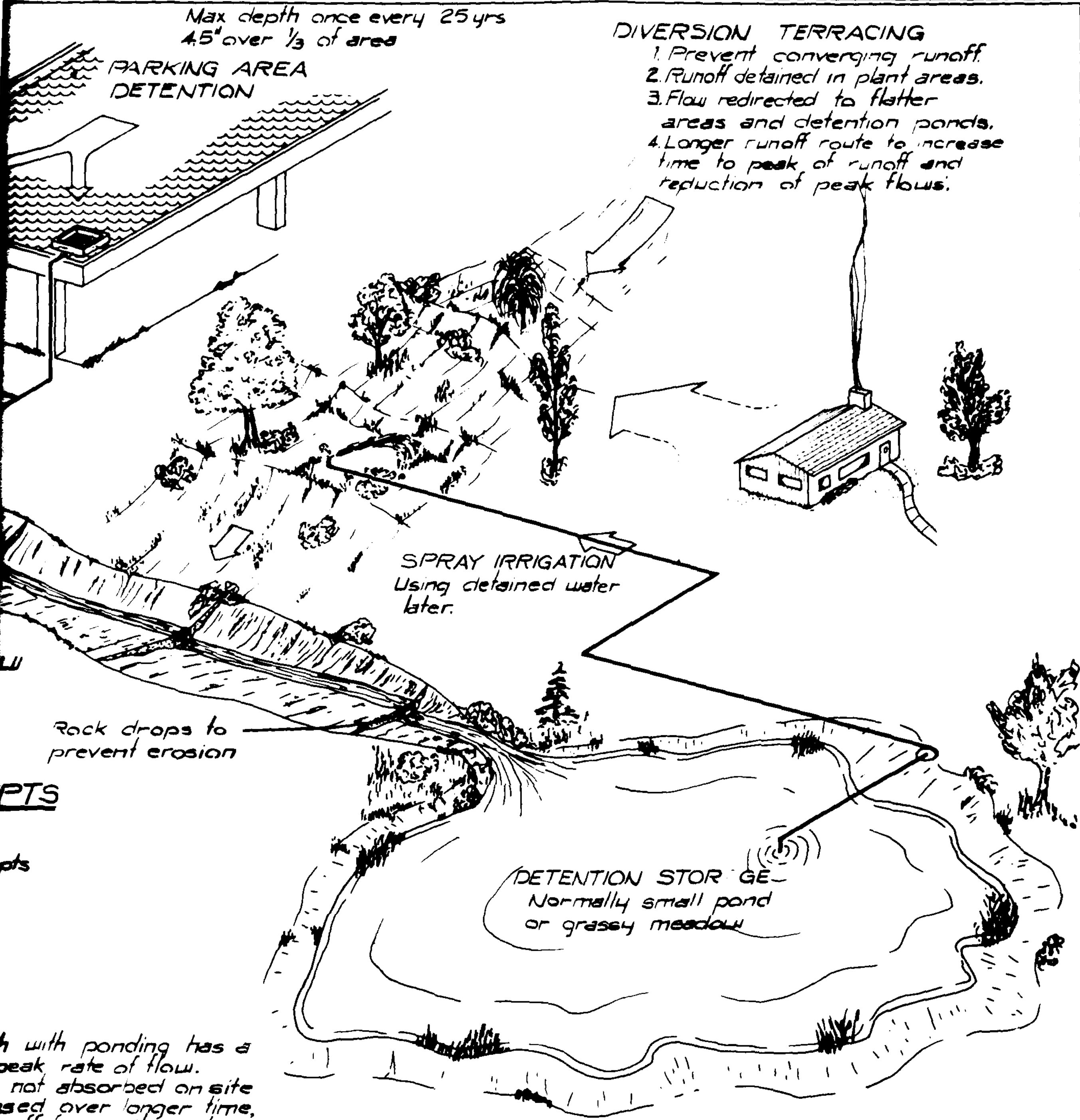


PONDING AND DETENTION CONCEPTS



HYDROGRAPH

EFFECTS OF PONDING AND DETENTION ON NEIGHBORS AND COMMU



PTS

ots

h with ponding has a
peak rate of flow.
not absorbed on site
sed over longer time,
noff from site is less
equal to historical flows.

CONCEPTUAL REPRESENTATION
TYPICAL UPSTREAM PONDING FOR P.U.D.

ORS AND COMMUNITY

FIGURE V-1

Early action programs have been proposed for several specific sites in the Study Area. They would provide data related to the projects listed above.

DRAINAGE DISTRICT, ROCKY RIVER 31
EARLY ACTION PROGRAM FOR STORM RUNOFF TREATMENT

The use of a 10 acre site for overland flow/infiltration of separate urban storm runoff from Drainage District R-31 would demonstrate the use of the Mahoning-Ellsworth Soils for an application rate of 150 inches per year. The land would be prepared as described in the Land Treatment Phase II Report, using the Mini-border system layout.

The early action effort would not include reservoir construction. Detained water would be applied directly to the land to provide a severe test of removal efficiency.

BURTON EARLY ACTION PROGRAM

Location of Collection Point

At the present time, the town of Burton treats approximately 0.30 MGD of wastewater by means of an Imhoff Tank. The plant is overloaded, effluent is reported to be bad, and the city has voted funds for a new treatment facility. The adjacent Town of Middlefield treats approximately 0.45 MGD in an aerated lagoon followed by a settling pond. The removal rates for suspended solids and BOD are reportedly in the neighborhood of 95 percent.

The proposed location of the new Burton plant for Plans A, B, and C is nearly a mile downstream from the existing Burton plant. This location provides for inclusion of new development outside the existing muncipal boundary lines. In Plan C, the old Burton plant site functions as a collection point for preliminary treatment before the wastewater flows into the aerated lagoon. The sites for the preliminary treatment and the aerated lagoon could be contiguous, however.

The land selected as most suitable for the effluent application and irrigation lies south of Burton and the Cuyahoga River. The proposed land site includes 420 irrigated acres; the capacity of the winter storage reservoir, based on 1990 wastewater flows, is 211 MG.* Stormwater would not be treated until 1990. An 18-inch transmission line, from the aerated lagoon to the storage reservoir will be more than adequate for the 2020 flows as the mitigating effect of the aerated lagoons on peak sewage flows will allow for pumping average daily flows.

* The local County Sanitary Engineer believes that year round irrigation is feasible on Chili soils, however.

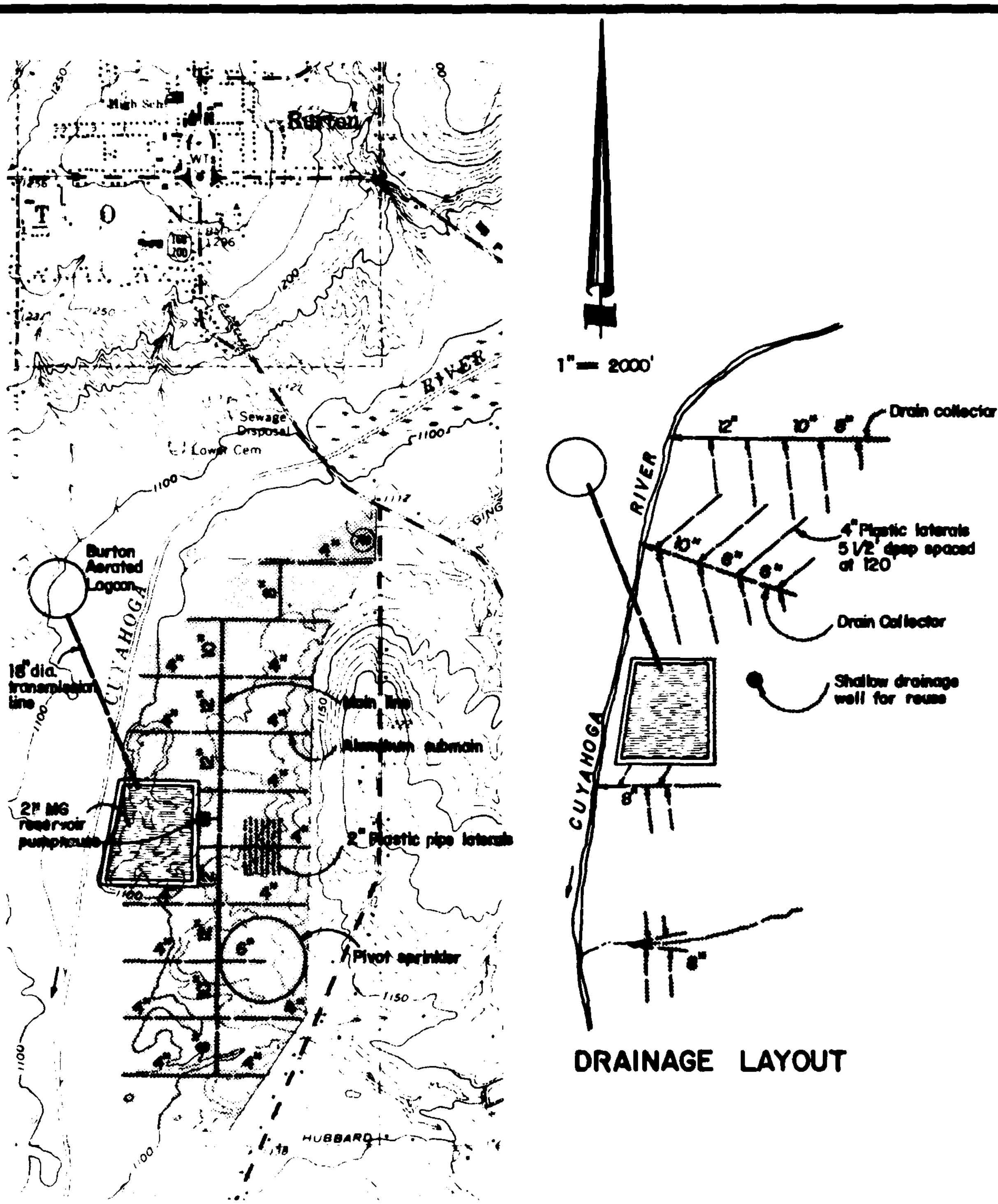
In Plan C it was conlcuded that the sewage from Middlefield would be collected and conveyed to the new Burton site. The early action land site, as shown in Figure V-2, is based upon a combined sewage collection and treatment system.

Irrigation System

The proposed land site lies on Chili soil. An application rate of 60 inches per year was chosen. Monitoring of this system may show that rates as high as 90 inches per year are feasible as hydraulic loading is not a limitation in the coarse-grained soils.

Two types of irrigation methods are possible for this area. Because much of the area is forested, a solid set system is the logical method. The main line will be either installed as a portable aluminum surface main line or buried main line. The capital costs for a completely buried system are high, but savings in man-power and better control required for high value crops may favor the permanent installation. The exact makeup of the solid-set system is a final design decision which will depend on the type of forest cover, the amount of clearing contemplated and the crops grown.

The center pivot sprinkler consists of a pipeline with sprinkler heads properly spaced. The pipeline is suspended above ground on tower units which can be electrically driven or water driven. The electrically powered units would be much the superior type for sewage effluent.



IRRIGATION LAYOUT

BURTON EARLY ACTION LAND TREATMENT SITE FOR 1990 FLOWS (420 ACRES)

FIGURE V-2

Drainage System

Because of the topography relative to the Cuyahoga River flood plain and the very pervious Chili soils, subsurface drainage will probably be required at only the low elevations as shown on Figure V-2. For the light application rates of two inches per week, a 4-inch drain plastic pipe spaced at 120 feet and installed at a depth of five and one-half feet should provide adequate drainage. If monitoring of the drainage effluent constituents indicates that higher applications are possible, the drain spacing could be decreased to 60 feet by installing a 4-inch plastic drain pipe in between the existing 4-inch pipe.

The size of the laterals is a final design feature which depends on the slope, length spacing, roughness factor and drainage coefficient. Similarly the size of the collector will depend on these factors as well as the area drained. A drainage coefficient of 3/8-inch in 24 hours should be adequate.

The drainage well shown is located to intercept water in the aquifer from the surrounding area. This water could be reused to supplement Burton's water supply if a good yielding well can be developed. At present, the depth and characteristic of the aquifer at this specific location is unknown. Should wells prove infeasible, however, collection of the effluent from the subsurface drains for reuse would also be feasible. Such reuse would help alleviate the potential problem of adequate drainage outlets.

Reservoir

The winter reservoir is located on a knoll as shown on Figure V-2. More information is required about the substratum to determine the need for lining the reservoir bottom and the side slopes. A more detailed study of the soils may indicate that another reservoir site within the land treatment area is more suitable than the one shown on Figure V-2.

Preliminary Investigation

The above description of the land site clearly indicates that a thorough final design investigation of the land treatment site is required before design progresses very far; however, the data to date shows that Burton and Middlefield are excellent candidates for land treatment early action work. Detailed studies and present constraints may indicate that the Middlefield aerated lagoon, which is now functioning very well, should initially be utilized for secondary treatment prior to land treatment.

In addition, the winter reservoir would be postponed while early action monitoring and testing was accomplished, and the results studied.

NEW MEDINA EARLY ACTION PROGRAM

At New Medina the overland flow/infiltration technique would be utilized on Mahoning soil with an annual application rate of 90 inches of municipal/industrial effluent per year.

BUCYRUS EARLY ACTION PROGRAM

The present population of Bucyrus is approximately 14,000 people. The existing treatment facilities were constructed in 1939 and expanded in 1961 to include the activated sludge process. Screening, comminution, grease removal and grit removal processes precede the secondary treatment phase. The plant discharges into the Sandusky River approximately one mile downstream of downtown Bucyrus. Bucyrus is a polluter of the river.

Because Bucyrus lies outside of the Three Rivers Study Area, the intention of this program is to test land treatment methods rather than to construct facilities for a long term solution to the wastewater problem of Bucyrus.

For this reason the plant facilities would be designed for approximately 2.0 MGD. Sizing for future loads would be outside the early action funding program, and construction associated with growth would be under conventional financing methods.

The facilities would include an aerated lagoon, pumping facilities, a winter storage reservoir, irrigation pumps and equipment, artificial drainage, and the acquisition of farmland. The facilities would provide the treatment needed to meet the 1985 Level 2 effluent standards.

The estimated costs which follow are based upon incomplete information, without the benefit of a field inspection of the site.

CAPITAL COSTS FOR THE COMPONENTS OF A 2.0 MGD LAND TREATMENT SYSTEM

Aerated Lagoons	$ 680,000
Pumping Plant to Reservoir	168,000
Force Main	105,000
Storage Reservoir	1,140,000
Reservoir Aeration & Chlorination	215,000
Land Purchase and Preparation	304,000
Irrigation System	266,000
Drainage System	181,000
Sludge Management	120,000
Miscellaneous	119,000
Total Construction Cost	$3,298,000

The total cost of the land treatment system, including contingencies, would amount to $4,300,000. The operation and maintenance and annual capital costs at a seven percent interest rate would be about $110,000 and $341,000, respectively, for operation at full capacity. This would result in a total annual cost of $451,000. Research and special monitoring by universities, state and federal agencies are not included.

This early action estimate is based upon the abandonment of the existing activated sludge plant which has a low reliability factor and problems in treating combined sewage during rainstorms. However, in more detailed studies, the expansion of the activated sludge plant should be analyzed with possible elimination of the aerated lagoon component. The cost effectiveness of this alternative should be determined.

In Bucyrus there is considerable local interest for treating the wastewater effluent on land. The proposed land treatment site would be multipurpose with up to 12 land management methods used on approximately 400 acres. Winter storage would be provided. Application of municipal

effluent at rates of 40, 60, 75, 90, 120, and 150 inches per year would be used, and heavy metals would be selectively introduced into the wastewater. The site would be located on Cardington-Bennington soil and would thus provide valuable information applicable to the Western Land Treatment Site.

This program would provide the needed field demonstration of land management methods for these fine-grained soils. A center-pivot rig would apply the wastewater on a selective basis to individual, but varied circular strips, using manually operated controls at the nozzles. The valving would permit applications to one strip, reduced applications to other strips, and no application of water to still other strips.

Drain systems of different depths and spacing would also be tested. Groundwater table and soil moisture measurements would be made.

Dissolved heavy metal solutions would be injected into the wastewater for application to selected fields in predetermined concentrations. Uptake of heavy metal to crops would be measured against concentrations in the soil. In the remaining areas lying between those irrigated by center-pivot rigs, solid-set sprinklers would be installed. Special valving on the solid-set sprinklers would permit selective application rates to particular tracts of land. See Figure III-2, Land Treatment Phase II Report.

LIVERPOOL EARLY ACTION PROGRAM, SLUDGE DISPOSAL ON AGRICULTURAL LAND

The Liverpool plant generated about 2.09 dry tons of sludge in 1972. The early ction program would consist of the application of sludge to an agricultural land site at rates of 5, 10, 15, 20, and perhaps up to

75 tons per year. Monitoring the effect of heavy metals and nutrients on the crops and drainage effluent would provide basic useful information. The site required would approximate 40 acres.

STRIP-MINED LAND EARLY ACTION PROGRAM

This program would involve piping the sludge from Ravenna and/or Willoughby Eastlake to strip-mined land in southeastern Ohio via an existing pipeline once used to pipe coal slurry to Lake Erie. The segment of this pipeline from Ravenna to the strip-mined area would require the least initial capital investment and pumping cost. In 1972, the Ravenna plant treated 2.05 MGD and produced 1.39 dry tons of sludge per day.

A simplified early action program for sludge would consist of hauling the Ravenna or Kent solids by tank truck.

Any early action sludge project should involve personnel from Case-Western University where a pool of expertise already exists.

WATER QUALITY AND QUALITY MONITORING SYSTEM

The monitoring program will be similar to that outlined in the *Havens & Emerson, Ltd., Phase III Report*. The reader is referred to that report for the Plan C early action work on monitoring.

SECTION VI

RESOURCE REQUIREMENTS

Wastewater treatment results in consumption of resources such as chemicals, power, land, and manpower. If any of the key resources used for the liquid or solid phase of the wastewater treatment are in short supply, the plan could be deficient unless alternative resources are available. The various resources required for the land treatment components of Plans A, B and C are summarized in Table VI-1.

A. Chemicals. The only chemical used for the land treatment in Plans B and C is chlorine for disinfection of the aerated lagoon effluent and the reservoir effluent. According to the Havens and Emerson, Ltd., Phase III Report, chlorine gas is fifth in the list of the top chemicals produced in the United States. National capacity at present is 28,960 tons per day, and the annual production increases have averaged eight percent per year.

Under present assumptions, chlorine would be required for the aerated lagoons and reservoirs. However, in the Western Land Treatment Area, which comprises the bulk of the chlorine use for Plan C, experiments could be conducted omitting chlorination.

B. Electric Power. As stated in the formulation contract, the energy requirement for Plan C in the year 2020 is 2.5 times the energy required for Plan A. A good deal of this power is utilized to pump the wastewater from the tunnel to the aerated lagoons in the Western Land Treatment Site. Some generation of power could be accomplished by

TABLE VI-1

ANNUAL RESOURCE REQUIREMENTS

YEAR AND PLAN	CHEMICALS (1000's TONS)			ELECTRIC POWER (1000's MWH)			LAND (1000's ACRES)			MANPOWER (PERSONS)		
	Waste-water	Storm-water	Total	Waste-water	Storm-water	Total	Waste-water	Storm-water	Total	Waste-water	Storm-water	Total
1980												
A	-	-	-	6.0	.1	6.1	.5	.2	.7	109	9	118
B	.5	-	.5	72.8	.1	72.9	.3	.1	.4	279	24	303
C	.7	-	.7	82.3	.1	82.4	4.4	.2	4.6	312	26	338
1990												
A	-	-	-	13.6	3.6	17.2	7.8	2.7	10.5	116	28	144
B	.7	.2	.9	164.4	19.0	183.4	15.1	4.8	19.9	359	87	446
C	11.0	2.4	13.4	458.3	211.4	669.7	121.5	27.1	148.6	355	86	441
2000												
A	-	-	-	14.3	4.0	18.3	8.8	3.1	11.9	133	35	168
B	1.4	.3	1.7	197.4	31.6	229.0	18.6	7.0	25.6	371	96	467
C	12.4	2.8	15.2	1,229.2	239.8	1,469.0	139.1	32.8	171.9	553	144	697
2010												
A	-	-	-	15.8	4.3	20.1	9.9	3.3	13.2	153	39	192
B	1.8	.4	2.2	235.1	37.9	273.0	22.3	8.1	30.4	418	108	526
C	13.7	3.1	16.8	1,354.8	263.0	1,617.8	154.1	36.1	190.2	619	160	779
2020												
A	-	-	-	17.3	4.4	21.7	11.7	3.5	15.2	170	43	213
B	2.1	.5	2.6	277.3	44.3	321.6	26.2	9.0	35.2	460	117	577
C	14.7	3.3	18.0	1,462.5	550.6	2,013.1	168.4	38.4	206.8	676	171	847

inserting turbines in shoreline access shafts to the tunnel. Another opportunity is to provide mined storage at the end of the tunnel so that power to lift the sewage to the aerated lagoons is off-peak or surplus power. The pump turbines could be reversible so that power could be generated during peak-power periods by reversing the flow from the aerated lagoon to the tunnel.

Plan C has an important built-in element which would facilitate the generation of electric power needed for wastewater treatment in excess of the scale projected in the study. This element is the creation of a large body of cooling water in the Western Land Treatment Area which would be utilized by a power plant. The adverse ecological effects normally associated with increased water temperatures would not be of concern and this same body of cooling water would become more efficient in its biological function of oxidizing the carbonaceous material in the wastewater.

C. Land. Plan C utilizes a considerable amount of land totaling 206,800 acres. Most of this land will be improved for agriculture production because of the nutrients and organic matter from the wastewater effluent or sludge. It has been estimated that the value of the produce from this land, at present prices, will amount to $36,000,000 a year.

The closely-spaced drainage system and alternate strips of corn and Reed Canarygrass in the Western Land Treatment Area will assure that the corn can be planted early and harvested on time.

D. Manpower. The manpower requirements shown in Tab [illegible] not be a constraint, but a benefit in terms of furnishing employment for workers in the agricultural industry.

E. Nutrients. The land treatment systems are designed to balance the nitrogen applied and the crop requirements. As a commercial fertilizer, the value of the nutrients in the sludge and wastewater for Plan C is estimated to be worth about $10,000,000 per year.

COST APPENDIX

The detailed computer tabulation of costs for each municipal plant and for the total costs of municipal/industrial wastewater and storm runoff treatment are presented in this appendix for Plan C.

Plant Number	Plant Name
1	Randolph
2	New Kent
3	Burton
4	Mantua
5	Butternut Creek
6	Chardon
7	East Claridon
8	Troy Township
9	Auburn
10	Shalersboro
11	Ravenna
12	Aurora Central
13	Fairmount Road
14	Fowler's Mill
15	Newbury Township
16	Chagrin Falls
17	Chagrin East Branch
18	Upper East Branch
19	Hinckley
20	Medina County
21	New Medina
22	Mallet Creek
23	Liverpool
26	Akron
27	Euclid
28	Lakewood

Plant Number	Plant Name
29	North Olmsted
30	Rocky River
31	Willoughby Eastlake
32	Easterly
33	Southerly
34	Westerly
35	Western Land Treatment Area
36	Interim Plants

Then follows:

Total Costs for Municipal/Industrial Wastewater Treatment
Total Costs for Stormwater Treatment
Total Costs for Wastewater and Stormwater Treatment

The costs for each treatment plant were assigned according to the particular components. The listing of components is the same in each of the following tables, even though a given plant may not have any costs for several components depending upon the treatment processes included in that plant. A brief explanation of the "components" follows:

1. PLANTS This item includes capital costs for replacement and expansion of existing secondary-level treatment facilities, new plant construction, even when built to meet Level I criteria, and construction of "preliminary" treatment facilities in conjunction with aerated lagoons or tunnel inlets. All operation and maintenance costs for water-based treatment plants, regardless of level, are included in this item, rather than being distributed among the first three items. For Storm Runoff, this component includes advanced stormwater treatment plants and preliminary treatment facilities

prior to separate land treatment. Costed by Havens & Emerson, Ltd. (H & E).

2. & 3. EXPAND TO LEVEL 1 and EXPAND TO LEVEL 2 These two items include only capital costs for municipal/industrial treatment plant components specifically classified as Level 1 or Level 2, (H & E) and do not reflect the operation and maintenance costs incurred by the expansion of the plant.

4. & 5. SLUDGE FACILITIES and SLUDGE FACILITIES EXPANSION These items include capital and operation and maintenance costs for both municipal/industrial and storm runoff sludge-handling facilities. (H & E) Where a sludge disposal scheme involves land treatment on either agricultural or strip-mined land, the storage, transportation, and application steps were costed by Wright-McLaughlin Engineers (WME) in Item Number 20.

6. & 7. SEWERS and SEWER EXPANSION These items include both the municipal/industrial and storm sewer systems costs for capital and operation and maintenance. (H & E)

8. & 9. DETENTION BASINS and BASIN EXPANSION These items relate only to capital costs for storm runoff. (H & E)

10. TEMPORARY PUMPS This is a special storm runoff item, which includes capital and operation and maintenance costs, and pertains only to an interim mode of treatment for combined sewer overflows in Plan C between 1980 and 1985. (WME)

11. SHAFTS and TUNNELS This item pertains only to the Transmission Tunnel in Plan C and includes capital and operation and maintenance costs allotted to both municipal/industrial and storm runoff in proportion to the average daily flow contributed to the tunnel from each source. The costs include mined storage space for flow-levelling and tunnel aeration equipment. (WME)

12. AERATED LAGOONS This item appears in Plans B and C where aerated lagoons were assumed for estimating costs of secondary treatment prior to land treatment in municipal systems. Both the aerobic and faculative lagoons are included in this item. Costs were prorated for storm runoff treated in municipal facilities. Site acquisition costs were included in this item. (WME)

13. SECONDARY PUMPING This item refers to capital and operation and maintenance costs for pumping municipal/industrial secondary effluent from aerated lagoons to winter storage reservoirs within the Study Area and for the lift from the lower end of the tunnel to the aerated lagoon at the Western Land Treatment Area. Pumping costs from detention basins to winter storage reservoirs were included for storm runoff. (WME)

14 FORCE MAINS This item pertains to all force mains associated with the pumping stations in the preceding item, including the lift shaft from the tunnel and force mains to winter storage reservoirs within the Study Area. (WME)

15. STORAGE RESERVOIRS This item refers to winter storage reservoirs for municipal/industrial secondary effluent and for preliminarily-treated storm runoff prior to land treatment. Land costs for site acquisition were included in this item. (WME)

16. RESERVOIR AERATION **and** CHLORINATION This item includes aeration and chlorination for municipal/industrial winter storage reservoirs for in-basin treatment and chlorination only for separate storm-runoff winter storage reservoirs, and for the Western Land Treatment Area reservoir. (WME)

17. LAND PURCHASE and PREPARATION This capital cost item includes two categories of land. The costs of site acquisition for water-based plants are treated as occurring in 1972 and are the only capital costs appearing in that year. (H & E) The costs for purchase of land treatment areas and the necessary "one-time" relocation, clearing, and land-forming costs occur later. (WME) All costs on this line are amortized over an assumed fifty-year life, but the total undepreciated expenditures are retained as the 2020 residual amounts for purposes of calculating present-worth costs.

18. IRRIGATION SYSTEMS This item comprises the distribution and irrigation systems from the winter storage reservoirs to the irrigated fields, including force mains and pumping facilities. (WME)

19. <u>DRAINAGE SYSTEMS</u> This item includes all portions of the drainage systems for the land treatment sites and the conduits and canals required to convey the tile effluent to natural drainage channels with adequate capacity. (WME)

20. <u>SLUDGE MANAGEMENT</u> This item includes costs for storage, transportation, and land application of sludge to receive land treatment. All costs for the pipeline to the strip-mined area are included in this item, as are costs of agricultural lands. (WME)

21. <u>MISCELLANEOUS</u> *This item is <u>not</u>* a contingency allowance, but rather an estimation of the costs for a category of appurtenances and ancillary features, which would be characteristic of the transition to a geographically dispersed land treatment system. Miscellaneous capital costs were calculated as follows: ten per cent of the capital expenditures for aerated lagoons, representing costs for fencing and for pipeline connections to existing treatment plants and to temporary stream return-flow structures from the aerated lagoons within the Study Area during the period 1977 to 1983; PLUS nine per cent of the capital expenditures for land purchase of an additional twenty per cent of the net acreage needed for land treatment; PLUS five per cent of the capital expenditures for both irrigation and drainage systems, representing costs for monitoring stations and some re-channeling of small creeks and streams. Miscellaneous operation and maintenance costs were calculated as five per cent of all foregoing miscellaneous capital expenditures. (WME)

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

RANDOLPH PLANT SIZE: 0.75(MGD) SOIL-T VPT:CHILI APPLICATION RATE: 60 IN/YR RANDOLPH PLANT

- - - - - BASIC DESIGN DATA - - - - -

1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	
																									POPULATION
			0.25	0.26	0.27	0.28	0.29	0.30	0.31	0.32	0.33	0.34	0.35	0.36	0.37	0.38	0.39	0.40	0.45	0.50	0.57	0.65	0.70	0.75	DOMESTIC AND INDUSTRIAL Q
				0.45						0.67								0.50	0.57	0.65	0.70	0.75	0.75	0.75	TREATMENT PLANT CAPACITY (MGD)
					0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.10	0.11	0.12	0.14	0.15	0.16	SLUDGE DISCHARGED (TPD)
			28	29	31	32	33	34	35	36	37	38	40	41	42	43	44	45	50	56	64	73	79	85	WINTER STORAGE (MG)
			56	58	60	63	65	67	69	72	74	76	78	81	83	85	87	89	101	112	128	146	157	168	LAND AREA (ACRE)

PLAN C PLANT 1 — PLAN C PLANT 1

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	0	0	0	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	0	0	46	16	22	1	21	20	0	19	17	0	17
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	211	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	211	21	180	1	178	172	0	171	158	0	158
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	210	0	0	0	0	0	0	0	0	0	0	0	0	0	0	160	0	0	0	210	0	580	244	240	19	220	205	9	196	164	2	162
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	71	0	0	0	0	0	0	0	71	0	0	0	0	71	0	213	71	77	5	71	60	2	58	41	0	40
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	150	36	88	2	85	76	1	74	57	0	57
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	250	0	0	0	0	0	0	0	50	0	120	0	90	0	0	553	240	223	19	203	178	9	169	123	2	121
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	47	0	0	0	0	0	0	0	59	0	75	0	85	0	85	351	85	86	6	79	62	3	59	37	0	36
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	53	0	0	0	0	0	0	0	8	8	11	11	7	7	0	0	111	53	8	44	44	4	40	33	1	32
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	45	0	0	0	5	0	0	0	5	6	7	8	5	50	5	136	61	42	4	37	32	2	30	22	0	21
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	32	0	0	0	4	0	0	0	5	5	6	7	4	5	0	68	15	28	1	26	22	0	21	15	0	15
SLUDGE MANAGEMENT	39	0	0	0	0	59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	0	0	0	59	0	144	62	61	5	56	53	2	51	44	0	43
MISCELLANEOUS	33	0	0	0	0	21	0	0	0	0	0	0	0	0	0	1	0	0	0	1	17	1	1	1	24	0	75	0	30	0	30	26	0	26	20	0	20
TOTAL		0	0	0	234	290	0	0	0	0	0	654	0	0	0	18	0	0	0	239	222	220	27	215	426	90	2524	962	1135	77	1058	956	37	918	737	9	727
PW (1/72) 5 3/8%		0	0	0	200	235	0	0	0	0	0	387	0	0	0	8	0	0	0	93	66	50	4	29	44	7	0	0	1135	77	1058	0	0	0	0	0	0
PW (1/72) 7%		0	0	0	190	221	0	0	0	0	0	332	0	0	0	6	0	0	0	70	46	33	2	16	23	3	0	0	0	0	0	956	37	918	0	0	0
PW (1/72) 10%		0	0	0	175	198	0	0	0	0	0	252	0	0	0	4	0	0	0	43	24	15	1	5	7	0	0	0	0	0	0	0	0	0	737	9	727

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	29	31	33	36	38	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	4	4	5	5	6	313	0	177	0	177	160	0	160	139	0	139
SLUDGE FACILITIES	35	1	1	1	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	14	0	14	13	0	13	12	0	12
SEWERS	50	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	45	0	14	0	14	11	0	11	7	0	7
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	0	0	9	9	10	10	10	10	10	10	10	10	11	11	11	12	17	17	18	18	19	604	0	154	0	154	111	0	111	66	0	66
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	5	5	5	6	6	6	6	9	9	10	10	11	11	11	339	0	73	0	73	49	0	49	25	0	25
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	3	3	3	77	0	15	0	15	10	0	10	5	0	5
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	3	3	4	4	4	104	0	21	0	21	14	0	14	7	0	7
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	3	3	4	4	4	5	5	5	246	0	31	0	32	21	0	21	11	0	11
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
SLUDGE MANAGEMENT	39	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	42	0	12	0	12	9	0	9	5	0	5
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		32	34	36	41	43	14	14	14	15	15	15	28	27	28	29	29	30	30	35	37	45	45	51	51	0	1761	0	533	0	0	414	0	0	288	0	0
PW (BEGIN PER) 5 3/8		30	32	34	38	40	13	13	13	14	14	14	26	25	26	27	27	28	28	154	175	192	204	217	218	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%		30	30	30	33	33	10	9	9	9	8	8	14	13	13	13	12	12	11	60	52	44	36	29	22	0	0	0	552	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%		29	31	33	38	40	13	13	13	14	14	14	26	25	26	27	27	28	28	147	168	186	197	211	208	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%		29	29	29	31	30	9	8	8	8	7	7	12	11	10	10	9	9	8	43	35	27	21	16	11	0	0	0	0	0	0	428	0	0	0	0	0
PW (BEGIN PER) 10%		29	30	32	37	39	12	12	12	13	13	13	25	24	25	26	26	27	27	130	155	172	184	188	155	1	43	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%		29	28	27	28	26	7	7	6	6	5	5	8	7	7	6	6	5	5	24	17	11	7	5	3	0	0	0	0	0	0	0	0	0	296	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	0	[illegible]	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1											
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SEWERS	50	0	0	0	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15											
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
AERATED LAGOONS	39	0	0	0	0	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	27	27	27	27	27	27											
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	5	5	5	5	5	5	5	5	11	11	11	11	11	11	11											
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10											
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	18	18	18	18	18	18	18	18	24	24	33	33	39	39	39											
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	7	7	7	7	7	7	7	7	9	9	12	12	14	14	[illegible]											
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	4	4	4	4	4	4	4	4	4	5	5	6	7	7	8											
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	3	3	3	4	4	5	6	6	6											
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	3	3	4	4	4	4											
SLUDGE MANAGEMENT	39	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
MISCELLANEOUS	33	0	0	0	0	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	3											
5 3/8% CRF		0	0	0	14	31	32	32	32	32	32	75	75	75	75	76	76	76	76	89	103	114	116	122	126	124											
7% CRF		0	0	0	16	36	36	36	36	36	36	91	91	91	91	92	92	92	92	108	125	137	140	149	150	150											
10% CRF		0	0	0	24	54	54	54	54	54	54	124	124	124	124	124	126	126	126	147	169	187	190	200	204	201											

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

CAPITAL RECOVERY FACTOR AT 5 3/8%

TOTAL ANNUAL CAPITAL [illegible]

CAPITAL RECOVERY FACTOR AT 7 %

TOTAL ANNUAL [illegible]

[illegible]

WASTEWATER MANAGEMENT STUDY
CLEVELAND AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

NEW RENT PLANT [illegible] SOIL-T [illegible] APPLICATION RATES 60 IN/YR NEW RENT PLANT

- - - - BASIC DESIGN DATA - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
POPULATION									83.2										112.8		126.7		147.7		163.4
DOMESTIC AND INDUSTRIAL =				4.25	4.73	9.22	9.70	10.19	10.68	11.20	[illegible]	12.25	12.78	13.30	13.83	14.35	14.98	15.40	15.93	[illegible]	22.15	22.40	24.65	26.53	[illegible]
TREATMENT PLANT CAPACITY (MGD)					28.36							15.91							20.15	22.4[illegible]	24.65	25.53	28.41	28.41	28.41
SLUDGE DISCHARGED (TPD)						1.96	2.06	2.16	2.25	2.35	2.4[illegible]	[illegible]	2.60	2.70	2.90	3.01	3.1[illegible]	3.23	3.33	3.7[illegible]	4.24	4.70	5.18	5.97	5.97
WINTER STORAGE (MG)												1384	1444	1503	1563	1622	1676	1740	1800	2035	2277	2331	2789	2498	3210
LAND AREA (ACRE)												2744	2863	2979	3098	3214	3333	3450	3568	4041	4514	5018	5522	5943	6386

PLAN C PLANT 2

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	0	-	-	180	0	0	0	0	0	0	0	0	0		0	0	0	0
EXPAND TO LEVEL 1	25	0			0	0	0	0	0	0	0	0	0	0		0	0	0	0
EXPAND TO LEVEL 2	25	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	4800	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	3047	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0		0	0	0	0	0	0	440	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	2860	0	0	0	0	0	0	0
STORAGE RESERVOIRS	40	0	0	0	0	0	0	0	0	0	0	4050	0	0	0	0	0	0	0
RESERVOIR AVA L C	10	0	0		0	0	0	0	0	0	0	1487	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	320	0	0	0	0	0	0	0	0	0	2230	0	0	0	140	0	0	0
IRRIGATION SYSTEM	35	0	0	0	0	0	0	0	0	0	0	2091	0	0	0	200	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	1360	0	0	0	85	0	0	0
SLUDGE MANAGEMENT	34	0	0	0	0	512	0	0	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	35	0	0	0	0	289	0	0	0	0	0	375	0	0	0	26	0	0	0
TOTAL		520	0	0	4980	3667	0	0	0	0	0	15891	0	0	0	451	0	0	0
PW (1/72) 5 3/8%		520	0	0	4257	2957	0	0	0	0	0	9407	0	0	0	216	0	0	0
PW (1/72) 7%		520	0	0	4065	2782	0	0	0	0	0	8072	0	0	0	176	0	0	0
PW (1/72) 10%		520	0	0	3739	2490	0	0	0	0	0	6133	0	0	0	118	0	0	0

ITEM	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	0	0	0	0	180	0	0	360	128	178	10	168	160	4	155	140	1	138
EXPAND TO LEVEL 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	0	0	0	0	0	0	0	4800	480	4104	38	4065	3916	18	3898	3604	4	3600
SEWER EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	1745	0	0	0	2653	0	7445	3107	3134	251	2882	2699	121	2578	2190	31	2159
SECONDARY PUMPING	395	0	0	0	0	440	0	1265	410	456	33	423	361	15	345	266	4	262
FORCE MAINS	0	0	0	0	0	0	0	2860	685	1693	55	1637	1452	26	1426	1103	6	1097
STORAGE RESERVOIRS	1465	0	1630	0	1380	0	0	9495	3844	4119	314	3804	3343	151	3192	2360	38	2321
RESERVOIR AVA L C	1457	0	2250	0	2582	0	2582	10758	2562	2687	209	2478	1939	100	1838	1159	25	1133
LAND PURCHASE & PREP	129	300	370	300	300	300	[illegible]	0	4265	2337	345	1991	1994	166	1828	1562	42	1515
IRRIGATION SYSTEM	272	272	290	290	242	2333	200	6190	2167	1934	175	1758	1506	84	1422	1019	21	998
DRAINAGE SYSTEMS	193	190	208	200	200	200	0	2636	1136	1110	91	1018	899	44	855	635	11	623
SLUDGE MANAGEMENT	0	234	0	0	0	512	0	1258	530	539	42	496	468	20	447	384	5	379
MISCELLANEOUS	52	224	58	51	49	438	10	1566	0	627	0	627	522	0	522	394	0	394
TOTAL	4553	2965	4776	841	4833	7675	2792	48633	19373	22922	1569	21353	19266	755	18510	14802	193	14608
PW (1/72) 5 3/8%	1775	894	1103	149	675	742	226	0	0	22922	1569	21353	0	0	0	0	0	0
PW (1/72) 7%	1347	627	716	89	374	389	109	0	0	0	0	0	19266	755	18510	0	0	0
PW (1/72) 10%	819	332	329	36	133	120	27	0	0	0	0	0	0	0	0	14802	193	14608

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	487	555	621	690	758	15	15	15	19	20	21	22	23	24	25	26	27	28
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	40	0	0	0	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
TEMPORARY PUMPS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	0	103	192	200	206	212	217	223	229	235	241	247	252	258
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	89	95	101	107	112	118	124
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	14	14	14	14	14	14	14
STORAGE RESERVOIRS	40	0	0	0	0	0	0	0	0	0	0	0	25	25	25	25	25	25	25
RESERVOIR AVA L C	[illegible]				0	0	0	0	0	0	0	0	96	99	99	101	103	106	109
LAND PURCHASE & PREP	[illegible]				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	[illegible]	0			0	0	0	0	0	0	0	0	90	92	93	95	97	98	100
DRAINAGE SYSTEMS	[illegible]					0	0	0	0	0	0	0	27	19	20	21	22	22	22
SLUDGE MANAGEMENT	35					0	12	12	13	13	14	15	15	16	16	17	17	18	19
MISCELLANEOUS	35					0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		487	555	621	713	781	142	241	265	275	283	290	644	664	682	701	719	736	755
PW (BEGIN PER) 5 3/8%		462	[illegible]	[illegible]	[illegible]	741	[illegible]	[illegible]	265	251	260	268	633	629	642	665	682	698	716
PW (1/72) 5 3/8%		462	[illegible]	[illegible]	[illegible]	[illegible]	190	179	176	171	167	162	343	335	327	319	311	302	296
PW BEGIN PER 7%		455	[illegible]	[illegible]	[illegible]	729	230	239	247	257	264	272	601	622	637	656	673	690	706
PW (1/72) 7%		455	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	155	[illegible]	149	143	137	205	275	264	251	243	233	223
PW (BEGIN PER) 10%		442	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	232	[illegible]	[illegible]	257	262	586	603	619	[illegible]	655	668	[illegible]
PW (1/72) 10%		442	[illegible]	[illegible]	484	484	139	131	123	116	109	101	205	192	179	167	155	145	135

ITEM	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	29	32	36	40	44	47	51	4983	0	2996	0	2996	2769	0	2769	2458	0	2458
SLUDGE FACILITIES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	23	23	23	23	23	23	23	1035	0	330	0	330	255	0	255	170	0	170
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	265	340	355	385	416	436	456	14345	0	3612	0	3612	2597	0	2597	1535	0	1535
SECONDARY PUMPING	129	141	152	164	176	186	197	5651	0	1228	0	1228	831	0	831	432	0	432
FORCE MAINS	14	14	14	14	14	14	16	518	0	125	0	125	87	0	87	47	0	47
STORAGE RESERVOIRS	32	32	40	40	47	47	47	1400	0	300	0	300	202	0	202	105	0	105
RESERVOIR AVA L C	111	124	138	151	165	173	180	5183	0	1127	0	1127	763	0	763	398	0	398
LAND PURCHASE & PREP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	101	112	123	133	143	148	152	4985	0	1015	0	1015	691	0	691	363	0	363
DRAINAGE SYSTEMS	22	28	30	33	36	38	38	1113	0	239	0	239	161	0	161	83	0	83
SLUDGE MANAGEMENT	19	22	24	26	29	31	33	682	0	244	0	244	175	0	175	103	0	103
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	778	903	980	1057	1143	1163	1163	39395	0	11220	0	0	8536	0	0	5695	0	0
PW (BEGIN PER) 5 3/8%	1556	4030	4362	4666	4927	5128	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%	1402	1205	1007	836	683	536	0	0	0	11629	0	0	0	0	0	0	0	0
PW BEGIN PER 7%	2467	3857	4173	4523	4841	4876	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%	1020	813	626	486	367	266	0	0	0	0	0	0	8819	0	0	0	0	0
PW (BEGIN PER) 10%	[illegible]	3576	3909	4220	4325	4557	50	1661	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%	571	399	269	181	116	77	0	0	0	0	0	0	0	0	0	5862	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	0			13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
EXPAND TO LEVEL 1	25	0			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0				0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0			345	345	345	345	345	345	345	345	345	345	345	345	345	345	345
SEWER EXPANSION	50	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0				0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	213	213	213	213	213	213	213	213	213	213	213	213	213	213
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	34	34	34	34	36	34	34	34
FORCE MAINS	50	0	0				0	0	0	0	0	205	205	205	205	205	205	205	205
STORAGE RESERVOIRS	40					0	0	0	0	0	0	363	363	363	363	363	363	363	363
RESERVOIR AVA L C	[illegible]					0	0	0	0	0	0	248	248	248	248	248	248	248	248
LAND PURCHASE & PREP	[illegible]	37	37	37	37	37	37	37	37	37	37	198	198	198	198	208	208	208	208
IRRIGATION SYSTEMS	[illegible]						0	0	0	0	0	163	163	163	163	178	178	178	178
DRAINAGE SYSTEMS	50		0				0	0	0	0	0	97	97	97	97	104	104	104	104
SLUDGE MANAGEMENT	35	0	0			38	38	38	38	38	38	38	38	38	38	38	38	38	38
MISCELLANEOUS	35		0	0	0	22	22	22	22	22	22	51	51	53	53	53	53	53	53
5 3/8% CRF		30	30	30	320	547	547	547	547	547	547	1636	1636	1636	1636	1664	1664	1664	1664
7% CRF		37	37	37	396	671	671	671	671	671	671	1976	1976	1976	1976	2007	2007	2007	2007
10% CRF		52	52	52	556	928	928	928	928	928	928	2670	2670	2670	2670	2716	2716	2716	2716

ITEM	1990	1995	2000	2005	2010	2015	2020
PLANTS	13	13	13	13	13	13	13
EXPAND TO LEVEL 1	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	0	0	0	0	0	0	0
SLUDGE FACILITIES	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	0	0	0	0	0	0	0
SEWERS	345	345	345	345	345	345	345
SEWER EXPANSION	0	0	0	0	0	0	0
DETENTION BASINS	0	0	0	0	0	0	0
BASIN EXPANSION	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0
AERATED LAGOONS	213	344	344	344	344	344	344
SECONDARY PUMPING	64	64	64	64	64	64	64
FORCE MAINS	205	205	205	205	205	205	205
STORAGE RESERVOIRS	469	465	586	586	[illegible]	683	683
RESERVOIR AVA L C	310	310	375	375	431	431	431
LAND PURCHASE & PREP	271	253	280	301	323	344	344
IRRIGATION SYSTEMS	155	[illegible]	243	266	285	304	304
DRAINAGE SYSTEMS	117	131	146	161	175	189	195
SLUDGE MANAGEMENT	38	55	55	55	55	55	55
MISCELLANEOUS	57	74	79	83	64	70	68
5 3/8% CRF	1883	2066	2277	2328	2490	[illegible]	2538
7% CRF	2268	2490	2740	2902	2993	3053	3052
10% CRF	[illegible]	3362	3652	3778	4023	4111	4111

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

CAPITAL RECOVERY FACTOR AT 5 3/8%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	[illegible]	[illegible]	[illegible]	320	547	547	547	547	547	547	1636	1636	1636	1636	1664	1664	1664	1664	1883	2066	2277	2328	2490	[illegible]	2538
TOTAL ANNUAL O & M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	265	275	283	290	644	664	682	701	719	736	755	778	903	980	1057	1143	1163	1163
TOTAL ANNUAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	812	827	830	1926	[illegible]	[illegible]	2318	[illegible]	[illegible]	[illegible]	2419	2661	2969	3257	3385	[illegible]	3702	[illegible]

CAPITAL RECOVERY FACTOR AT 7%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	37	37	[illegible]	396	[illegible]	671	671	671	671	671	1976	1976	1976	1976	2007	2007	2007	2007	[illegible]	[illegible]	[illegible]	2902	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL O & M	[illegible]	555	[illegible]	[illegible]	761	247	256	265	275	283	290	566	666	[illegible]	[illegible]	719	736	755	[illegible]	[illegible]	[illegible]	1057	1143	[illegible]	[illegible]
TOTAL ANNUAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	918	927	936	946	954	2266	2618	[illegible]	2656	[illegible]	2726	2743	2762	[illegible]	[illegible]	[illegible]	3959	[illegible]	[illegible]	4243

CAPITAL RECOVERY FACTOR AT 10%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	[illegible]	[illegible]	[illegible]	556	[illegible]	[illegible]	928	928	928	928	2670	2670	2670	2670	2716	2716	2716	2716	[illegible]	[illegible]	[illegible]	3778	[illegible]	[illegible]	4111
TOTAL ANNUAL O & M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	256	265	275	283	[illegible]	566	[illegible]	[illegible]	[illegible]	[illegible]	736	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1143	[illegible]	[illegible]
TOTAL ANNUAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1184	1193	1203	1211	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3452	[illegible]	3471	[illegible]	[illegible]	[illegible]	[illegible]	5176	[illegible]	[illegible]

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

BURTON PLANT SIZE: 3.61(MGD) SOIL-T YPE(CHEL) APPLICATION RATE: 50 IN/YR BURTON PLANT

- - - - - BASIC DESIGN DATA - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
POPULATION																									
DOMESTIC AND INDUSTRIAL Q				1.17	1.21	1.25	1.29	1.34	1.38	1.43	1.48	1.53	1.58	1.63	1.67	1.72	1.77	1.82	1.87	2.08	2.28	2.62	2.95	3.28	3.61
TREATMENT PLANT CAPACITY (MGD)					2.08						1.87								2.28	2.62	2.95	3.28	3.61	3.61	3.61
SLUDGE DISCHARGED (TPD)						0.26	0.27	0.28	0.29	0.30	0.31	0.32	0.33	0.34	0.35	0.36	0.37	0.39	0.40	0.44	0.48	0.55	0.62	0.65	0.76
WINTER STORAGE (MG)											167	175	178	184	189	194	200	206	211	235	258	296	333	371	406
LAND AREA (ACRE)											332	343	354	365	374	385	397	408	419	466	511	587	661	735	809

PLAN C PLANT 3

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	0	0	0	57	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	970	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	492	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	30	0	0	0	0	545	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	182	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	97	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	822	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	181	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	36	0	0	0	279	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	248	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	189	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	34	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	33	0	0	0	0	101	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		36	0	0	1027	2736	0	0	0	492	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%		36	0	0	878	2217	0	0	0	323	0	0	0	0	0	0	0	0	0
PW (1/72) 7%		36	0	0	838	2086	0	0	0	286	0	0	0	0	0	0	0	0	0
PW (1/72) 10%		36	0	0	771	1867	0	0	0	229	0	0	0	0	0	0	0	0	0

ITEM	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	PRESENT WORTH AT 5 3/8% RESID	PRESENT WORTH AT 5 3/8% NET	PRESENT WORTH AT 7% EXPEND	PRESENT WORTH AT 7% RESID	PRESENT WORTH AT 7% NET	PRESENT WORTH AT 10% EXPEND	PRESENT WORTH AT 10% RESID	PRESENT WORTH AT 10% NET
PLANTS	0	0	0	0	57	0	0	114	40	56	3	53	50	1	49	44	0	43
EXPAND TO LEVEL 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	0	0	0	0	0	0	0	970	97	829	7	821	791	3	787	728	0	727
SEWER EXPANSION	240	0	0	0	0	0	0	732	193	417	15	401	357	7	349	272	1	271
DETENTION BASINS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	388	0	0	0	545	0	1478	424	615	50	565	527	24	503	424	6	418
SECONDARY PUMPING	83	0	0	0	182	0	0	447	135	204	10	193	177	5	172	144	1	142
FORCE MAINS	0	0	0	0	0	0	0	97	12	70	0	69	66	0	65	59	0	59
STORAGE RESERVOIRS	230	0	345	0	340	0	0	1737	686	882	55	827	772	26	746	635	6	628
RESERVOIR AER & CL	226	0	284	0	349	0	364	1404	364	377	29	348	288	14	274	196	3	193
LAND PURCHASE & PREP	61	0	100	0	98	0	0	[illegible]	538	322	43	279	289	20	268	247	5	241
IRRIGATION SYSTEMS	77	0	75	0	322	0	0	722	261	292	21	271	247	10	237	197	2	194
DRAINAGE SYSTEMS	61	0	68	0	46	0	0	364	136	194	11	183	171	5	166	142	1	141
SLUDGE MANAGEMENT	0	28	0	0	0	100	0	228	92	100	7	92	87	3	84	73	0	72
MISCELLANEOUS	11	38	16	0	28	56	0	249	0	110	0	110	95	0	95	77	0	77
TOTAL	969	454	888	0	1442	699	364	8531	3178	4474	257	4217	3924	123	3800	3245	31	3213
PW (1/72) 5 3/8%	377	156	205	0	197	73	29	0	0	4474	257	4217	0	0	0	0	0	0
PW (1/72) 7%	286	95	133	0	109	38	14	0	0	0	0	0	3924	123	3800	0	0	0
PW (1/72) 10%	174	50	61	0	38	11	3	0	0	0	0	0	0	0	0	3245	31	3213

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	124	136	148	158	168	3	3	3	4	6	8	10	12	18	21	24	27	30
SLUDGE FACILITIES	35	8	9	9	10	11	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	6	6	6	6	6	7	7	7	7	7	7	7	7	7	7
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	30	0	0	0	0	0	30	31	31	32	32	33	34	34	35	35	36	36	36
SECONDARY PUMPING	33	0	0	0	0	0	13	13	14	14	15	15	15	15	16	16	16	16	17
FORCE MAINS	50	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1
STORAGE RESERVOIRS	50	0	0	0	0	0	4	4	4	4	4	4	4	4	4	4	4	4	4
RESERVOIR AER & CL	10	0	0	0	0	0	11	11	11	11	12	12	12	12	12	13	13	13	13
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	11	11	11	11	11	11	11	11	11	11	11	11	11
DRAINAGE SYSTEMS	50	0	0	0	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3
SLUDGE MANAGEMENT	35	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		136	147	157	172	181	87	88	89	94	98	101	104	106	113	118	121	125	129
PW (BEGIN PER) 5 3/8%		129	139	148	163	173	82	83	84	89	92	95	98	100	107	112	114	118	122
PW (1/72) 5 3/8%		129	132	136	139	140	63	60	58	58	56	55	53	54	53	53	52	51	[illegible]
PW (BEGIN PER) 7%		127	137	146	160	171	81	82	83	87	91	94	97	99	105	112	113	116	120
PW (1/72) 7%		127	[illegible]	129	131	130	57	54	51	51	49	47	46	43	43	42	41	39	39
PW (BEGIN PER) 10%		123	135	142	156	166	79	80	81	85	89	91	94	96	102	107	[illegible]	113	117
PW (1/72) 10%		123	121	117	117	114	49	45	41	38	37	35	33	30	29	28	26	24	23

ITEM	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	PRESENT WORTH AT 5 3/8% RESID	PRESENT WORTH AT 5 3/8% NET	PRESENT WORTH AT 7% EXPEND	PRESENT WORTH AT 7% RESID	PRESENT WORTH AT 7% NET	PRESENT WORTH AT 10% EXPEND	PRESENT WORTH AT 10% RESID	PRESENT WORTH AT 10% NET
PLANTS	33	20	7	8	9	10	11	1274	0	792	0	792	721	0	721	625	0	625
SLUDGE FACILITIES	0	0	0	0	0	0	0	47	0	39	0	39	38	0	38	35	0	35
SEWERS	8	8	8	8	8	8	8	330	0	95	0	95	71	0	71	45	0	45
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	37	39	56	60	63	66	68	2108	0	528	0	528	380	0	380	226	0	226
SECONDARY PUMPING	19	20	21	24	24	26	28	880	0	228	0	228	166	0	166	99	0	99
FORCE MAINS	1	1	1	1	1	1	1	43	0	12	0	12	9	0	9	6	0	6
STORAGE RESERVOIRS	5	6	7	8	9	9	9	272	0	66	0	66	47	0	47	28	0	28
RESERVOIR AER & CL	14	14	18	20	22	22	23	726	0	185	0	185	134	0	134	80	0	80
LAND PURCHASE & PREP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	13	13	16	16	20	20	20	648	0	167	0	167	122	0	122	73	0	73
DRAINAGE SYSTEMS	3	3	3	3	5	5	5	159	0	42	0	42	31	0	31	19	0	19
SLUDGE MANAGEMENT	3	3	3	3	4	4	5	126	0	32	0	32	23	0	23	14	0	14
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	141	132	147	158	171	177	0	6613	0	2191	0	0	1745	0	0	1253	0	0
PW (BEGIN PER) 5 3/8%	582	595	651	700	742	758	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%	227	178	150	124	101	79	0	0	0	2266	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%	558	569	629	674	721	724	[illegible]	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%	185	120	93	72	54	39	0	0	0	0	0	0	1800	0	0	0	0	0
PW (BEGIN PER) 10%	611	627	593	679	644	676	0	235	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%	92	55	40	27	17	11	0	0	0	0	0	0	0	0	0	1296	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	0	0	0	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	35	35	35	35	35	35	35	35	35	35
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	30	0	0	0	0	40	40	40	40	40	40	40	40	40	40	40	40	40	40
SECONDARY PUMPING	33	0	0	0	0	14	14	14	14	14	14	14	14	14	14	14	14	14	14
FORCE MAINS	50	0	0	0	0	6	6	6	6	6	6	6	6	6	6	6	6	6	6
STORAGE RESERVOIRS	50	[illegible]	0	[illegible]	0	59	59	59	59	59	59	59	59	59	59	59	59	59	59
RESERVOIR AER & CL	10	0	0	[illegible]	0	20	20	20	20	20	20	20	20	20	20	20	20	20	20
LAND PURCHASE & PREP	50	[illegible]	2	2	2	22	22	22	22	22	22	22	22	22	22	22	22	22	22
IRRIGATION SYSTEMS	33	[illegible]	[illegible]	[illegible]	0	19	19	19	19	19	19	19	19	19	19	19	19	19	19
DRAINAGE SYSTEMS	50	[illegible]	[illegible]	0	0	13	13	13	13	13	13	13	13	13	13	13	13	13	13
SLUDGE MANAGEMENT	35	[illegible]	[illegible]	[illegible]	0	7	7	7	7	7	7	7	7	7	7	7	7	7	7
MISCELLANEOUS	33	0	0	0	0	7	7	7	7	7	7	7	7	7	7	7	7	7	7
[illegible] 5 3/8%		2	2	2	61	235	235	235	235	263	263	263	263	263	263	263	263	263	263
[illegible] 7%		2	2	2	76	286	286	286	286	321	321	321	321	321	321	321	321	321	321
[illegible] 10%		1	1	1	107	392	392	392	392	441	441	441	441	441	441	441	441	441	441

ITEM	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEN
PLANTS	4	4	4	4	4	4	4	
EXPAND TO LEVEL 1	0	0	0	0	0	0	0	
EXPAND TO LEVEL 2	0	0	0	0	0	0	0	
SLUDGE FACILITIES	0	0	0	0	0	0	0	
SLUDGE FAC. EXP.	0	0	0	0	0	0	0	
SEWERS	69	69	69	69	69	69	69	
SEWER EXPANSION	52	52	52	52	52	52	52	
DETENTION BASINS	0	0	0	0	0	0	0	
BASIN EXPANSION	0	0	0	0	0	0	0	
TEMPORARY PUMPS	0	0	0	0	0	0	0	
SHAFTS & TUNNELS	0	0	0	0	0	0	0	
AERATED LAGOONS	40	69	69	69	69	69	69	
SECONDARY PUMPING	20	20	20	20	20	20	20	
FORCE MAINS	6	6	6	6	6	6	6	
STORAGE RESERVOIRS	75	75	100	100	125	125	125	
RESERVOIR AER & CL	25	25	[illegible]	32	[illegible]	39	41	
LAND PURCHASE & PREP	27	27	34	34	41	41	41	
IRRIGATION SYSTEMS	25	25	31	31	36	36	[illegible]	
DRAINAGE SYSTEMS	16	16	21	21	26	26	26	
SLUDGE MANAGEMENT	7	9	9	9	9	9	9	
MISCELLANEOUS	8	11	12	12	7	11	11	
[illegible] 5 3/8%	312	340	405	382	447	421	[illegible]	
[illegible] 7%	381	41[illegible]	452	466	542	516	[illegible]	
[illegible] 10%	523	565	669	639	737	704	[illegible]	

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

CAPITAL RECOVERY FACTOR AT 5 3/8%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL		[illegible]	2	61	235	235	235	235	263	263	263	263	263	263	263	263	263	263	312	340	405	382	447	421	[illegible]
TOTAL ANNUAL O&M	[illegible]	147	157	172	[illegible]	87	88	89	94	98	101	104	106	113	118	121	125	129	141	132	147	158	171	177	178
TOTAL ANNUAL COST	[illegible]	[illegible]	159	[illegible]	[illegible]	[illegible]	[illegible]	324	357	361	364	367	369	376	381	384	388	392	453	472	552	540	618	[illegible]	[illegible]

CAPITAL RECOVERY FACTOR AT 7%

[illegible]

CAPITAL RECOVERY FACTOR AT 10%

[illegible]

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

MANTUA PLANT SIZE: 0.861MGD SOIL-7 WPE(CHILI) APPLICATION RATE: 60 IN/YR MANTUA PLANT

- - - - - BASIC DESIGN DATA - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
POPULATION DOMESTIC AND INDUSTRIAL				0.327	0.335	0.343	0.352	0.360	0.368	0.381	0.394	0.408	0.421	0.434	0.447	0.460	0.474	0.487	0.500	0.540	0.580	0.660	0.740	0.801	0.861
TREATMENT PLANT CAPACITY (MGD)					0.540						0.500								0.580	0.660	0.743	0.801	0.861	0.861	0.861
SLUDGE DISCHARGED (TPD)						0.07	0.07	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.11	0.11	0.12	0.14	0.16	0.17	0.18
WINTER STORAGE (MG)												46	48	49	50	52	54	55	56	56	66	75	84	91	97
LAND AREA (ACRE)												91	94	97	100	103	106	109	112	121	130	148	166	179	193

PLAN C PLANT 4

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	230	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	64	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	58	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	277	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	56	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	67	0	0	0	8	0	0	0
IRRIGATION SYSTEMS	35	0	0	0	0	0	0	0	0	0	0	73	0	0	0	5	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	40	0	0	0	5	0	0	0
SLUDGE MANAGEMENT	39	0	0	0	0	64	0	0	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	33	0	0	0	0	23	0	0	0	0	0	11	0	0	0	1	0	0	0
TOTAL		0	0	0	25	317	0	0	0	0	0	643	0	0	0	22	0	0	0
PW (1/72) 5 3/8%		0	0	0	21	257	0	0	0	0	0	380	0	0	0	10	0	0	0
PW (1/72) 7 %		0	0	0	20	241	0	0	0	0	0	326	0	0	0	8	0	0	0
PW (1/72) 10 %		0	0	0	18	216	0	0	0	0	0	244	0	0	0	5	0	0	0

	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	0	0	0	0	25	0	0	50	17	24	1	23	22	0	21	19	0	19
EXPAND TO LEVEL 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	170	0	0	0	230	0	630	265	261	21	240	224	10	213	180	2	177
SECONDARY PUMPING	0	0	0	0	0	64	0	128	55	44	4	40	36	2	33	25	0	25
FORCE MAINS	0	0	0	0	0	0	0	58	14	34	1	33	29	0	28	22	0	22
STORAGE RESERVOIRS	80	0	106	0	79	0	0	542	225	230	18	212	186	8	177	130	2	128
RESERVOIR AER & CL	64	0	80	0	92	0	92	384	92	96	7	89	69	3	66	42	0	42
LAND PURCHASE & PREP	6	6	12	12	9	9	0	0	129	54	10	44	44	5	39	31	1	30
IRRIGATION SYSTEMS	5	4	9	8	7	77	8	196	87	61	7	54	48	3	44	33	0	32
DRAINAGE SYSTEMS	4	3	8	7	6	5	0	78	33	32	2	30	26	1	25	18	0	18
SLUDGE MANAGEMENT	0	28	0	0	0	64	0	156	61	67	4	62	58	2	55	47	0	47
MISCELLANEOUS	0	17	1	1	1	27	0	82	0	34	0	34	28	0	28	22	0	22
TOTAL	159	226	216	28	219	476	100	2304	978	943	75	863	774	38	736	574	9	564
PW (1/72) 5 3/8%	42	68	49	4	30	49	8	0	0	943	79	863	0	0	0	0	0	0
PW (1/72) 7 %	47	48	32	2	16	26	3	0	0	0	0	0	774	38	736	0	0	0
PW (1/72) 10 %	26	15	14	1	5	8	1	0	0	0	0	0	0	0	0	574	9	564

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	42	44	45	47	49	2	2	2	2	2	2	2	2	3	3	3	3	3
SLUDGE FACILITIES	35	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	0	10	10	10	10	10	10	11	11	11	11	11	12	12
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	5	5	5	5	5	6	6
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	4
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	35	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	3
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
SLUDGE MANAGEMENT	39	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		45	47	48	50	51	14	14	14	14	14	14	29	29	30	30	32	32	33
PW (BEGIN PER) 5 3/8%		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PW (1/72) 5 3/8%		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PW (BEGIN PER) 7%		42	43	44	46	47	15	13	13	15	13	13	27	27	28	27	28	29	30
PW (1/72) 7%		42	41	39	38	36	9	8	8	7	7	6	12	12	11	10	10	10	9
PW (BEGIN PER) 10%		40	42	43	45	46	12	12	12	12	12	12	26	26	27	27	27	29	30
PW (1/72) 10%		40	38	36	34	31	7	7	6	5	5	4	9	8	7	7	6	6	5

	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	3	3	4	4	5	5	6	377	0	230	0	230	211	0	211	186	0	186
SLUDGE FACILITIES	0	0	0	0	0	0	0	15	0	12	0	12	12	0	12	11	0	11
SEWERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	12	14	18	19	20	21	22	674	0	170	0	170	122	0	122	73	0	73
SECONDARY PUMPING	6	6	6	7	7	7	8	232	0	53	0	53	36	0	36	19	0	19
FORCE MAINS	1	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
STORAGE RESERVOIRS	2	2	2	2	2	2	2	67	0	14	0	14	9	0	9	5	0	5
RESERVOIR AER & CL	4	4	4	4	5	5	5	152	0	34	0	34	23	0	23	12	0	12
LAND PURCHASE & PREP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	3	3	4	4	4	4	5	146	0	31	0	31	21	0	21	11	0	11
DRAINAGE SYSTEMS	1	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
SLUDGE MANAGEMENT	1	1	1	1	1	1	1	43	0	12	0	12	9	0	9	6	0	6
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	34	37	42	44	48	49	51	1780	0	578	0	0	459	0	0	331	0	0
PW (BEGIN PER) 5 3/8%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	593	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%	143	155	176	189	198	204	3	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%	42	33	26	20	15	11	0	0	0	0	0	0	471	0	0	0	0	0
PW (BEGIN PER) 10%	132	147	165	176	177	191	1	43	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%	23	18	11	7	4	3	0	0	0	0	0	0	0	0	0	331	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
EXPAND TO LEVEL 1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	30	30	30	30	30	30
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	19	19	19	19	19	19	19	19	25	25	33	33	39	39	39
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	9	9	9	9	9	9	9	9	10	10	13	13	15	15	15
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	4	4	4	4	5	5	5	5	5	6	7	7	8	9	9
IRRIGATION SYSTEMS	35	0	0	0	0	0	0	0	0	0	0	5	5	5	5	6	6	6	6	6	6	7	8	8	9	9
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	2	2	2	2	3	3	3	3	3	3	4	4	5	5	5
SLUDGE MANAGEMENT	39	0	0	0	0	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	6	5	6	6	6	6
MISCELLANEOUS	33	0	0	0	0	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	4	4	4	2	3	3
5 3/8% CRF		0	0	0	1	21	21	21	21	21	21	65	65	65	65	66	66	66	66	73	87	97	99	105	108	134
7 % CRF		0	0	0	1	25	25	25	25	25	25	78	78	78	78	79	79	79	79	88	105	117	119	127	133	130
10 % CRF		0	0	0	2	34	34	34	34	34	34	105	105	105	105	107	107	107	107	115	141	158	161	171	175	175

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
CAPITAL RECOVERY FACTOR AT 5 3/8%																									
TOTAL ANNUAL CAPITAL	0	0	0	1	21	21	21	21	21	21	65	65	65	65	66	66	66	66	73	87	97	99	105	108	134
TOTAL ANNUAL O&M	45	47	48	50	51	14	14	14	14	14	14	29	29	30	30	32	32	33	34	37	42	44	48	49	51
TOTAL ANNUAL COSTS	45	47	48	51	72	35	35	35	35	35	79	94	94	95	96	98	98	99	107	124	139	143	153	157	185
CAPITAL RECOVERY FACTOR AT 7 %																									
TOTAL ANNUAL CAPITAL	0	0	0	1	25	25	25	25	25	25	78	78	78	78	79	79	79	79	88	105	117	119	127	133	130
TOTAL ANNUAL O&M	45	47	48	50	51	14	14	14	14	14	14	29	29	30	30	32	32	33	34	37	42	44	48	49	51
TOTAL ANNUAL COSTS	45	47	48	51	76	39	39	39	39	39	92	107	107	108	109	111	111	112	122	142	159	163	175	182	181
CAPITAL RECOVERY FACTOR AT 10 %																									
TOTAL ANNUAL CAPITAL	0	0	0	2	34	34	34	34	34	34	105	105	105	105	107	107	107	107	115	141	158	161	171	175	175
TOTAL ANNUAL O&M	45	47	48	50	51	14	14	14	14	14	14	29	29	30	30	32	32	33	34	37	42	44	48	49	51
TOTAL ANNUAL COSTS	45	47	48	52	85	48	48	48	48	48	119	134	134	135	137	139	139	140	149	178	200	205	219	224	226

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

BUTTERNUT CREEK PLANT SIZE: [illegible] SCOPE SPECIFIC APPLICATION RATE: 66 [illegible] BUTTERNUT CREEK PLANT

- - - - BASIC DESIGN DATA - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
POPULATION																									
DOMESTIC AND INDUSTRIAL Q				0.30	0.31	0.32	0.33	0.35	0.37	0.38	0.39	0.40	0.42	0.43	0.44	0.46	0.47	0.48	0.50	0.57	0.66	0.78	0.9[illegible]	1.03	1.17
TREATMENT PLANT CAPACITY (MGD)					3.58						0.50								0.66	0.78	0.89	1.03	1.17	1.17	1.17
SLUDGE DISCHARGED (TPD)						0.07	0.07	0.07	0.08	0.08	0.09	0.08	0.09	0.09	0.09	0.10	0.10	0.10	0.11	0.12	0.14	0.16	0.19	0.22	0.25
WINTER STORAGE (MG)												45	47	49	50	52	53	54	57	65	75	88	101	116	132
LAND AREA (ACRES)												90	94	96	99	103	105	108	112	133	148	175	199	231	262

PLAN C PLANT 9

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	0	0
EXPAND TC LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TC LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC CITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	448	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	[illegible]	0	0	0	0	240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	240	0	0	0	240	0
SECONDARY PUMPING	[illegible]	0	0	0	0	0	0	0	0	0	0	71	0	0	0	0	0	0	0	71	0	0	0	0	71	0
FORCE MAINS	[illegible]	0	0	0	0	0	0	0	0	0	0	120	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	[illegible]	0	0	0	0	0	0	0	0	0	0	300	0	0	0	0	0	0	0	130	0	170	0	195	0	0
RESERVOIR AERATION	[illegible]	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	76	0	100	0	130	0	130
LAND PURCHASE & PREP	50	12	0	0	0	0	0	0	0	0	0	66	0	0	0	9	0	0	0	12	12	18	16	22	21	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	80	0	0	0	10	0	0	0	9	9	13	12	16	96	13
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	40	0	0	0	5	0	0	0	7	7	11	10	11	15	0
SLUDGE MANAGEMENT	[illegible]	0	0	0	0	49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34	0	0	0	69	0
MISCELLANEOUS	[illegible]	0	0	0	0	24	0	0	0	0	0	33	0	0	0	1	0	0	0	1	25	2	2	3	31	0
TOTAL		12	0	0	509	333	0	0	0	448	0	748	0	0	0	25	0	0	0	306	327	314	40	407	541	140
PW [illegible] 5 3/8 %		12	0	0	436	277	0	0	0	307	0	642	0	0	0	12	0		0	119	98	72	7	55	56	11
PW [illegible] 7 %		11	0	0	414	254	0	0	0	272	0	379	0	0	0	9	0	2	0	90	68	47	4	30	29	5
PW [illegible] 10 %		12	0	0	381	227	0	0	0	216	0	280	0	0	0	6	0	0	0	55	36	21	1	10	9	1

ITEM	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	56	19	27	1	26	24	0	24	21	0	21
EXPAND TC LEVEL 1	0	0	0	0	0	0	0	0	0	0	0
EXPAND TC LEVEL 2	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC CITIES	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	0	0	0	0	0	0	0	0	0	0	0
SEWERS	400	48	410	3	406	391	1	389	360	0	360
SEWER EXPANSION	448	93	307	7	300	272	3	268	218	0	217
DETENTION BASINS	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	720	295	291	23	267	246	11	235	194	2	191
SECONDARY PUMPING	213	71	77	5	71	60	2	58	42	0	40
FORCE MAINS	120	29	71	2	68	60	1	59	46	0	46
STORAGE RESERVOIRS	795	382	294	30	265	231	14	216	154	3	152
RESERVOIR AERATION	496	130	116	10	104	82	5	77	48	1	47
LAND PURCHASE & PREP	0	186	75	15	60	62	7	55	46	1	44
IRRIGATION SYSTEMS	255	118	76	9	67	59	4	54	39	1	38
DRAINAGE SYSTEMS	136	42	38	3	34	30	3	28	20	0	20
SLUDGE MANAGEMENT	172	67	73	5	67	63	2	61	52	0	51
MISCELLANEOUS	100	0	38	0	38	32	0	32	24	0	24
TOTAL	3561	1490	1900	119	1780	1619	57	1562	1271	14	1256
PW [illegible] 5 3/8 %	0	0	1900	119	1780	0	0	0	0	0	0
PW [illegible] 7 %	0	0	0	0	0	1619	57	1562	0	0	0
PW [illegible] 10 %	0	0	0	0	0	0	0	0	1271	14	1256

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	15	10	41	44	41	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	4	4	5	6	7
SLUDGE FAC. [illegible]	35	[illegible]	2	[illegible]	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	[illegible]	[illegible]	[illegible]	2	2	2	2	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
TEMPORARY PUMPS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOON	[illegible]	0	0	0	0	0	11	11	11	11	11	12	12	12	12	12	12	13	13	13	19	22	23	24	25	27
SECONDARY PUMPING	[illegible]	0	0	0	0	0	0	0	0	0	0	0	6	6	7	8	8	9	9	10	10	11	11	12	12	14
FORCE MAINS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
STORAGE RESERVOIRS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	2	2	[illegible]	2	2	2	2	2	2	2	3	3	3	3
RESERVOIR AERATION	10	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	3	4	4	5	5	7	7	7
LAND PURCHASE & PREP	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	4	4	4	4	4	4	4	5	5	6	6	7	7	7
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2
SLUDGE MANAGEMENT	15	0	0	0	0	[illegible]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
MISCELLANEOUS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]
TOTAL		17	60	63	68	51	17	17	17	19	19	20	37	37	38	39	39	41	41	45	47	59	61	68	70	[illegible]
PW [illegible]		15	57	60	65	68	16	16	16	18	18	18	35	35	36	37	37	38	38	196	227	257	273	294	308	[illegible]
PW [illegible]		15	16	16	38	39	11	11	11	11	11	11	19	19	18	17	16	16	15	76	68	59	48	40	32	[illegible]
PW [illegible]		16	57	60	66	67	14	15	15	17	17	18	34	34	35	36	36	38	38	198	237	246	263	285	294	[illegible]
PW [illegible]		16	16	15	16	16	11	10	9	10	9	9	16	15	14	14	13	12	12	55	45	36	28	21	16	0
PW [illegible]		33	36	35	61	66	15	15	15	17	17	18	33	33	34	35	35	37	37	173	201	230	245	255	275	2
PW [illegible]		33	18	12	12	11	9	8	7	8	7	7	11	10	9	9	8	8	7	21	22	15	10	6	6	0

ITEM	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	556	0	210	0	210	191	0	191	167	0	167
SLUDGE FAC. [illegible]	10	0	8	0	8	8	0	8	7	0	7
SEWERS	173	0	50	0	50	37	0	37	23	0	23
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOON	788	0	193	0	193	138	0	138	81	0	81
SECONDARY PUMPING	388	0	85	0	85	58	0	58	30	0	30
FORCE MAINS	37	0	8	0	8	6	0	6	3	0	3
STORAGE RESERVOIRS	89	0	19	0	19	13	0	13	7	0	7
RESERVOIR AERATION	186	0	38	0	38	25	0	25	13	0	13
LAND PURCHASE & PREP	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	208	0	45	0	45	30	0	30	16	0	16
DRAINAGE SYSTEMS	47	0	9	0	9	6	0	6	3	0	3
SLUDGE MANAGEMENT	43	0	12	0	12	9	0	9	6	0	6
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0	0
TOTAL	2322	0	683	0	0	526	0	0	361	0	0
PW [illegible]	0	0	0	0	0	0	0	0	0	0	0
PW [illegible]	0	0	705	0	0	0	0	0	0	0	0
PW [illegible]	0	0	0	0	0	0	0	0	0	0	0
PW [illegible]	0	0	0	0	0	542	0	0	0	0	0
PW [illegible]	63	0	0	0	0	0	0	0	0	0	0
PW [illegible]	0	0	0	0	0	0	0	0	369	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	0	0	2	2	2	2	2	2	2	2	2	[illegible]	2	2	2	2	2	2	2	2	2	2	2	2
EXPAND TC LEVEL 1	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TC LEVEL 2	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. [illegible]	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	[illegible]	0	0	0	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
SEWER EXPANSION	[illegible]	0	0	0	0	0	0	0	0	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
DETENTION BASINS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOON	[illegible]	0	0	0	0	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	36	36	36	36	36	36
SECONDARY PUMPING	[illegible]	0	0	0	0	0	0	0	0	0	0	5	5	5	5	5	5	5	5	11	11	11	11	11	11	11
FORCE MAINS	[illegible]	0	0	0	0	0	0	0	0	0	0	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
STORAGE RESERVOIRS	[illegible]	0	0	0	0	0	0	0	0	0	0	21	21	21	21	21	21	21	21	30	30	43	43	57	57	57
RESERVOIR AERATION	[illegible]	0	0	0	0	0	0	0	0	0	0	10	10	10	10	10	10	10	10	12	[illegible]	15	16	21	21	21
LAND PURCHASE & PREP	[illegible]	0	0	0	0	0	0	0	0	0	0	5	5	5	5	6	6	6	6	7	7	9	10	12	13	13
IRRIGATION SYSTEMS	[illegible]	0	0	0	0	0	0	0	0	0	0	6	6	6	6	7	7	7	7	7	8	9	10	11	12	12
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	2	2	2	2	3	3	3	3	3	4	5	5	6	7	7
SLUDGE MANAGEMENT	15	0	0	0	0	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	7	7	7	7	[illegible]	7
MISCELLANEOUS	[illegible]	0	0	0	0	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	4	4	5	3	5	4
[illegible]			[illegible]	[illegible]	35	51	51	51	51	78	78	128	128	128	128	130	130	130	130	146	146	183	185	203	207	207
[illegible]				0	37	62	62	62	62	96	96	156	156	156	156	158	158	158	158	178	203	222	225	246	251	251
[illegible]				1	52	86	86	86	86	133	133	215	215	215	215	217	217	217	217	244	277	303	307	336	343	343

TOTAL EXPEND TOTAL RESID PRESENT WORTH AT 5 3/8% EXPEND RESID NET PRESENT WORTH AT 7% EXPEND RESID NET PRESENT WORTH AT 10% EXPEND RESID NET

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

CAPITAL RECOVERY FACTOR AT 5 3/8%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	[illegible]		[illegible]	35	51	51	51	51	78	78	128	128	128	128	130	130	130	130	146	[illegible]	183	185	203	207	207
TOTAL ANNUAL O&M	17	[illegible]	63	68		17	17	17	19	19	20	37	37	[illegible]	[illegible]	[illegible]	41	41	45	47	59	61	68	70	74
TOTAL ANNUAL	[illegible]		63	78		68	68	68	97	97	148	165	165	[illegible]	[illegible]	169	171	171	191	213	242	246	[illegible]	[illegible]	281

CAPITAL RECOVERY FACTOR AT 7 %

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	156	156	156	[illegible]	[illegible]	158	158	178	203	[illegible]	225	246	[illegible]	251
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	38	[illegible]	[illegible]	41	41	45	47	[illegible]	61	68	70	74
TOTAL ANNUAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	193	193	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	223	250	[illegible]	286	[illegible]	[illegible]	325

CAPITAL RECOVERY FACTOR AT 10 %

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	343
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

CHARDON PLANT SIZE: 0.20(MGD) SOIL-TYPE: PERMANENT APPLICATION RATE: 90 IN/YR CHARDON PLANT

- - - - - BASIC DESIGN DATA - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
POPULATION																									
DOMESTIC AND INDUSTRIAL W				0.05					0.07	0.07	0.08	0.08	0.09	0.08	0.09	0.09	0.09	0.10	0.10	0.11	0.13	0.15	0.17	0.18	0.20
TREATMENT PLANT CAPACITY (MGD)					0.11						0.10								0.13	0.15	0.17	0.18	0.20	0.20	0.20
SLUDGE DISCHARGED (TPD)									0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.04
WINTER STORAGE (MG)												7	7	7	8	8	8	8	8	5	11	13	14	15	17
LAND AREA (ACRE)												12	12	12	13	13	13	15	15	16	19	23	26	27	30

PLAN C PLANT 6

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	27	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	90	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	9	0	0	0	1	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	13	0	0	0	1	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	4	0	0	0	1	0	0	0
SLUDGE MANAGEMENT	39	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	33	0	0	0	0	10	0	0	0	0	0	1	0	0	0	0	0	0	0
TOTAL		0	0	0	0	122	0	0	0	10	0	219	0	0	0	3	0	0	0
PW (1/72) 5 3/8%		0	0	0	0	98	0	0	0	6	0	129	0	0	0	1	0	0	0
PW (1/72) 7 %		0	0	0	0	93	0	0	0	5	0	111	0	0	0	1	0	0	0
PW (1/72) 10 %		0	0	0	0	83	0	0	0	4	0	84	0	0	0	0	0	0	0

PLAN C PLANT 6

	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	0	0	0	0	0	10	0	20	8	7	0	6	6	0	6	4	0	4
EXPAND TO LEVEL 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	90	0	0	0	100	0	290	122	117	9	108	100	4	96	80	1	78
SECONDARY PUMPING	0	0	0	0	0	60	0	120	52	41	4	37	33	2	31	24	0	23
FORCE MAINS	0	0	0	0	0	0	0	27	8	15	0	15	13	0	13	10	0	10
STORAGE RESERVOIRS	90	0	0	0	0	0	0	180	58	88	4	83	72	2	70	50	0	50
RESERVOIR AER & CL	17	0	21	0	25	0	25	101	25	24	2	22	17	0	16	10	0	10
LAND PURCHASE & PREP	2	1	3	2	1	2	0	0	21	8	1	6	6	0	5	4	0	4
IRRIGATION SYSTEMS	1	0	2	0	1	14	1	33	14	10	1	9	8	0	7	5	0	5
DRAINAGE SYSTEMS	2	0	2	1	1	1	0	14	3	5	0	5	4	0	4	3	0	3
SLUDGE MANAGEMENT	0	12	0	0	0	12	0	36	13	14	1	13	12	0	11	9	0	9
MISCELLANEOUS	0	9	0	0	0	10	0	30	0	12	0	12	10	0	10	8	0	8
TOTAL	112	112	28	3	28	209	26	851	322	348	26	322	287	12	274	212	3	209
PW (1/72) 5 3/8%	43	33	6	0	3	21	2	0	0	348	26	322	0	0	0	0	0	0
PW (1/72) 7 %	33	23	4	0	2	11	1	0	0	0	0	0	287	12	274	0	0	0
PW (1/72) 10 %	20	12	1	0	0	5	0	0	0	0	0	0	0	0	0	212	3	209

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMP	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	0	4	4	4	4	4	4	4	4	4	4	4	4	4
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	3	3
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
SLUDGE MANAGEMENT	39	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		0	0	0	0	0	5	5	5	5	5	5	13	13	13	13	13	13	13
PW (BEGIN PER) 5 3/8%		0	0	0	0	0	5	5	5	5	5	5	12	12	12	12	12	12	12
PW (1/72) 5 3/8%		0	0	0	0	0	4	3	3	3	2	2	6	6	5	5	5	5	5
PW (BEGIN PER) 7%		0	0	0	0	0	4	4	4	4	4	4	12	12	12	12	12	12	12
PW (1/72) 7%		0	0	0	0	0	3	3	2	2	2	2	5	5	5	4	4	4	3
PW (BEGIN PER) 10%		0	0	0	0	1	4	4	4	4	4	4	11	11	11	11	11	11	11
PW (1/72) 10%		0	0	0	0	0	2	2	2	2	1	1	4	3	3	3	2	2	2

	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	0	0	0	0	1	1	1	10	0	1	0	1	0	0	0	0	0	0
SLUDGE FACILITIES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	4	5	7	7	7	8	8	247	0	62	0	62	45	0	45	27	0	27
SECONDARY PUMPING	3	3	4	4	4	4	4	131	0	29	0	29	20	0	20	10	0	10
FORCE MAINS	1	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
STORAGE RESERVOIRS	1	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
RESERVOIR AER & CL	1	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
LAND PURCHASE & PREP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	1	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
DRAINAGE SYSTEMS	1	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
SLUDGE MANAGEMENT	1	1	1	1	1	1	1	43	0	12	0	12	9	0	9	6	0	6
MISCELLANEOUS	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
TOTAL	13	14	17	17	19	19	0	616	0	150	0	0	106	0	0	61	0	0
PW (BEGIN PER) 5 3/8%	55	64	72	72	76	81	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%	21	19	16	12	10	8	0	0	0	150	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%	53	61	69	69	74	77	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%	15	12	10	7	5	4	0	0	0	0	0	0	106	0	0	0	0	0
PW (BEGIN PER) 10%	49	56	65	65	66	72	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%	5	4	4	2	1	1	0	0	0	0	0	0	0	0	0	61	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	14	14	14	14	14	14
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	6	6	6	6	6	6	6	6	12	12	12	12	12	12	12
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	3	3	4	4	4
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
SLUDGE MANAGEMENT	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	1
5 3/8% CRF		0	0	0	0	7	7	7	7	8	8	22	22	22	22	22	22	22	22	25	36	37	37	37	38	38
7 % CRF		0	0	0	0	9	9	9	9	9	9	27	27	27	27	27	27	27	27	35	43	44	44	45	46	46
10 % CRF		0	0	0	0	12	12	12	12	13	13	36	36	36	36	37	37	37	37	47	55	60	60	60	62	62

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
CAPITAL RECOVERY FACTOR AT 5 3/8%																									
TOTAL ANNUAL CAPITAL			0	0	7	7	7	7	8	8	22	22	22	22	22	22	22	22	25	36	37	37	37	38	38
TOTAL ANNUAL O&M			0	0	0	5	5	5	5	5	5	13	13	13	13	13	13	13	13	14	17	17	19	19	19
TOTAL ANNUAL COST		0	0	0	7	12	12	12	13	13	27	35	35	35	35	35	35	35	42	50	54	54	55	57	57
CAPITAL RECOVERY FACTOR AT 7 %																									
TOTAL ANNUAL CAPITAL	0	0	0	0	9	9	9	9	9	9	27	27	27	27	27	27	27	27	35	43	44	44	45	46	46
TOTAL ANNUAL O&M	0	0	0	0	0	5	5	5	5	5	5	13	13	13	13	13	13	13	13	14	17	17	19	19	19
TOTAL ANNUAL COST	0	0	0	0	9	14	14	14	14	14	32	40	40	40	40	40	40	40	48	57	61	61	[illegible]	65	65
CAPITAL RECOVERY FACTOR AT 10 %																									
TOTAL ANNUAL CAPITAL	0				12	12	12	12	13	13	36	36	36	36	37	37	37	37	47	55	60	60	60	62	62
TOTAL ANNUAL O&M					0	5	5	5	5	5	5	13	13	13	13	13	13	13	13	14	17	17	19	19	19
TOTAL ANNUAL COST					12	17	17	17	18	18	41	49	49	49	[illegible]	[illegible]	50	50	60	69	77	77	79	81	81

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

EAST CLARIDON PLANT SIZE: [illegible] SOIL-T PRETREATMENT APPLICATION RATE: 96 IN/YR EAST CLARIDON PLANT

- - - - - BASIC DESIGN DATA - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
POPULATION																									
DOMESTIC AND INDUSTRIAL Q				0.11	0.11	0.12	0.12	0.13	0.14	0.14	0.15	0.16	0.16	0.17	0.18	0.19	0.16	0.20	0.21	0.26	0.31	0.35	0.35	0.43	0.48
TREATMENT PLANT CAPACITY (MGD)					0.25						0.21								0.32	0.35	0.39	0.43	0.45	0.48	0.48
SLUDGE DISCHARGED (TPD)						0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.06	0.07	0.07	0.08	0.09	0.10
WINTER STORAGE (MG)												18	18	19	20	21	21	23	24	29	35	40	44	49	54
LAND AREA (ACRE)												36	36	38	40	43	43	44	47	58	70	79	87	96	108

PLAN C PLANT 7

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	36	12	17	0	16	16	0	15	14	0	13
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120	12	102	0	101	97	0	97	90	0	90
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0		0		150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	140	0	0	0	150	0	440	183	179	14	164	152	7	145	120	1	118
SECONDARY PUMPING	14	0			0	0	0	0	0	0	0	78	0	0	0	0	0	0	0	0	0	0	0	0	78	0	156	67	54	5	48	43	2	41	31	0	30
FORCE MAINS	50	0	0		0	0	0	0	0	0	0	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36	9	21	0	20	18	0	17	13	0	13
STORAGE RESERVOIRS	50				0		0	0	0	0	0	130	0	0	0	0	0	0	0	78	0	70	0	74	0	0	352	280	133	22	111	105	10	94	71	2	68
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	30	0	40	0	45	0	45	180	45	42	3	38	30	1	28	17	0	17
LAND PURCHASE & PREP	50	5	0	0	0	0	0	0	0	0	0	27	0	0	0	5	0	0	0	7	8	6	5	6	8	0	0	72	32	5	26	26	2	23	19	0	19
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	25	0	0	0	2	0	0	0	3	3	2	2	2	28	2	69	31	22	2	19	17	1	16	11	0	11
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	18	0	0	0	3	0	0	0	5	5	4	4	4	5	0	48	18	18	1	16	14	0	13	9	0	9
SLUDGE MANAGEMENT	39	0	0	0	0	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	36	0	90	35	38	2	35	33	1	31	27	0	26
MISCELLANEOUS	33	0	0	0	0	15	0	0	0	0	0	4	0	0	0	0	0	0	0	1	15	0	0	0	17	0	52	0	21	0	21	17	0	17	13	0	13
TOTAL		5	0	0	138	201	0	0	0	0	0	338	0	0	0	10	0	0	0	124	185	122	11	149	322	47	1579	764	686	61	622	573	29	543	441	7	433
PW (1/72) 5 3/8%		5	0	0	117	163	0	0	0	0	0	200	0	0	0	4	0	0	0	48	56	28	1	20	33	3	0	0	686	61	622	0	0	0	0	0	0
PW (1/72) 7%		5	0	0	112	153	0	0	0	0	0	171	0	0	0	3	0	0	0	36	39	18	1	11	17	1	0	0	0	0	0	573	29	543	0	0	0
PW (1/72) 10%		5	0	0	103	137	0	0	0	0	0	130	0	0	0	2	0	0	0	22	21	8	0	4	5	0	0	0	0	0	0	0	0	0	441	7	433

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	11	12	13	14	15	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	3	3	3	3	4	158	0	76	0	76	67	0	67	56	0	56
SLUDGE FACILITIES	35	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	4	0	4	4	0	4	3	0	3
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	0	6	6	6	6	6	6	6	6	6	6	6	6	6	7	8	12	12	13	13	14	413	0	101	0	101	72	0	72	42	0	42
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	4	4	4	4	4	4	4	5	5	6	6	6	6	7	199	0	44	0	44	30	0	30	16	0	16
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	47	0	9	0	9	6	0	6	3	0	3
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	2	2	2	2	3	3	3	3	85	0	17	0	17	11	0	11	6	0	6
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
SLUDGE MANAGEMENT	39	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	43	0	12	0	12	9	0	9	6	0	6
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		12	13	14	15	17	8	8	8	8	8	8	17	17	17	17	18	18	19	21	22	28	29	31	31	[illegible]	1051	0	294	0	0	221	0	0	145	0	0
PW (BEGIN PER) 5 3/8		11	12	13	14	15	7	7	7	7	7	7	16	16	16	16	17	17	18	89	107	120	128	132	137	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%		11	11	11	12	12	5	5	5	4	4	4	9	8	8	7	7	7	7	35	32	27	22	18	14	0	0	0	296	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%		11	12	13	14	14	7	7	7	7	7	7	15	15	15	15	16	16	17	86	102	114	123	129	130	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%		11	11	11	11	11	5	4	4	4	4	3	7	7	6	6	5	5	5	25	21	17	13	9	7	0	0	0	0	0	0	223	0	0	0	0	0
PW (BEGIN PER) 10%		10	11	12	13	14	7	7	7	7	7	7	15	15	15	15	16	16	17	79	96	107	115	116	122	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%		10	10	10	10	9	6	4	3	3	3	2	5	4	4	3	3	3	3	14	10	7	4	3	2	0	0	0	0	0	0	0	0	0	145	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1											
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SEWERS	50	0	0	0	0	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8											
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
AERATED LAGOONS	39	0	0	0	0	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	21	21	21	21	21	21											
SECONDARY PUMPING	14	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	0	5	5	5	5	5	5	5	5	5	5	5	5	5	5											
FORCE MAINS	50	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2											
STORAGE RESERVOIRS	50	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	0	9	9	9	9	9	9	9	9	14	20	20	25	25	25											
RESERVOIR AER & CL	10	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	0	3	3	3	3	3	3	3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
LAND PURCHASE & PREP	50	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
IRRIGATION SYSTEMS	33	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
DRAINAGE SYSTEMS	50	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
SLUDGE MANAGEMENT	39	[illegible]	0	0	[illegible]	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
MISCELLANEOUS	33	[illegible]	[illegible]	[illegible]	[illegible]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
5 3/8% CRF		[illegible]	[illegible]	0	4	27	27	20	20	20	20	43	43	43	43	43	43	43	43	50	[illegible]	60	60	76	76	76											
7% CRF		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
10% CRF		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	102	[illegible]	114	122	125	125											

- - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - -

CAPITAL RECOVERY FACTOR AT [illegible]

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL			0	4	27	27	20	20	20	20	43	43	43	43	43	43	43	43	[illegible]	[illegible]	60	60	76	76	76
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8	8	8	8	8	17	17	17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL COST	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	28	[illegible]	[illegible]	28	51	60	60	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CAPITAL RECOVERY FACTOR AT [illegible]

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	25	25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL O&M	12	13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL COST	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	111	121	121	125

CAPITAL RECOVERY FACTOR AT [illegible]

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	35	[illegible]	35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL COST	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON [illegible] WATERSHED AREA

TROY TOWNSHIP PLANT [illegible] TROY TOWNSHIP PLANT

- - - - BASIC DESIGN DATA - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
POPULATION																									
CONNECTED AN INDUSTRIAL & [illegible]				0.12	0.15	0.13	0.14	0.14	0.15	0.15	0.16	0.17	0.17	0.18	0.18	0.19	0.20	0.20	0.21	[illegible]	0.29	0.33	0.38	0.42	0.47
TREATMENT PLANT CAPACITY (MGD)					0.25						0.21								0.29	0.33	[illegible]	[illegible]	[illegible]	0.47	0.47
SLUDGE DISCHARGED (TPD)									0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	[illegible]	0.05	[illegible]	[illegible]	[illegible]	[illegible]	0.10
WINTER STORAGE (MG)												18	19	20	20	21	23	23	25	28	33	37	41	47	53
LAND AREA (ACRES)												38	38	40	40	43	45	45	47	56	65	76	85	96	135

PLAN C PLANT 5

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	30	0	0	0	0	145	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	84	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	138	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	26	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	4	0	0	0	0	0	0	0	0	0	27	0	0	0	5	0	0	0
IRRIGATION SYSTEM	33	0	0	0	0	0	0	0	0	0	0	28	0	0	0	5	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	16	0	0	0	1	0	0	0
SLUDGE MANAGEMENT	15	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	33	0	0	0	0	14	0	0	0	0	0	6	0	0	0	0	0	0	0
TOTAL		5	0	0	18	159	0	0	0	0	0	383	0	0	0	13	0	0	0
PW (1/72) 5 3/8%		5	0	0	15	153	0	0	0	0	0	276	0	0	0	6	0	0	0
PW (1/72) 7 %		5	0	0	14	144	0	0	0	0	0	196	0	0	0	5	0	0	0
PW (1/72) 10 %		5	0	0	13	129	0	0	0	0	0	147	0	0	0	4	0	0	0

	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	0	0	0	0	18	0	0	36	12	17	0	16	16	0	15	14	0	13
EXPAND TO LEVEL 1	0	0	0	0	0	0	0	0	0	0			0	0	0	0	0	0
EXPAND TO LEVEL 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	0			0	0		0		0	0		0	0	0	0	0	0	0
SLUDGE FAC. EXP.	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0
SEWERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	130	0	0	0	145	0	420	175	171	14	157	141	6	135	116	1	116
SECONDARY PUMPING	60	0	0	0	0	60	0	190	61	65	4	60	[illegible]	2	49	36	0	36
FORCE MAINS	0	0	0	0	0	0	0	84	20	69	[illegible]	48	42	0	41	32	0	32
STORAGE RESERVOIRS	60	0	49	0	66	0	0	313	139	125	11	114	100	5	94	69	1	67
RESERVOIR AER & CL	35	0	46	0	55	0	55	217	55	51	4	47	36	2	34	21	0	20
LAND PURCHASE & PREP	6	6	6	7	6	7	0	[illegible]	70	31	5	26	26	2	23	19	0	18
IRRIGATION SYSTEM	4	5	4	5	4	33	5	93	42	28	3	24	21	1	20	14	0	14
DRAINAGE SYSTEMS	4	4	4	5	4	5	0	45	17	16	1	15	13	0	12	8	0	8
SLUDGE MANAGEMENT	0	24	0	0	0	30	0	84	27	34	2	32	29	1	28	23	0	23
MISCELLANEOUS	0	13	0	1	0	17	0	49	[illegible]	15	0	19	16	0	16	17	0	17
TOTAL	165	182	105	18	173	297	60	1521	618	612	50	562	500	24	476	367	6	361
PW (1/72) 5 3/8%	69	54	25	3	29	31	4			612	50	562	0	0	0		0	0
PW (1/72) 7 %	50	39	16	1	11	16	2		0	0	0	0	500	24	476		0	0
PW (1/72) 10 %	30	20	7	0	4	5	0		0	0	0	0	0	0		367	6	361

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	13	15	16	17	18	1	1	1	1	1	1	1	1	1	1	1	1	1
SLUDGE FACILITIES	35	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	30	0	0	0	0	0	6	6	6	6	6	6	6	6	6	6	6	6	7
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	4	4	4	4	4	4	4
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	2	2
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
SLUDGE MANAGEMENT	35	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		14	16	17	18	19	8	8	8	8	8	8	17	17	17	17	17	18	19
PW (BEGIN PER) 5 3/8%		13	15	15	17	18	7	7	7	7	7	7	16	16	16	16	16	17	18
PW (1/72) 5 3/8%		13	14	14	14	14	5	5	5	4	4	4	9	8	8	7	7	7	7
PW (BEGIN PER) 7%		13	14	15	16	17	7	7	7	7	7	7	15	15	15	15	15	16	17
PW (1/72) 7%		13	13	13	13	13	5	4	4	4	4	3	7	7	6	6	5	5	4
PW (BEGIN PER) 10%		12	14	15	16	17	7	7	7	7	7	7	15	15	15	15	15	16	17
PW (1/72) 10%		12	13	12	17	11	4	4	3	3	3	2	5	4	4	4	3	3	3

	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	2	2	2	2	3	3	4	162	0	86	0	86	77	0	77	66	0	66
SLUDGE FACILITIES	0	0	0	0	0	0	0	5	0	4	0	4	4	0	4	3	0	3
SEWERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	7	7	12	12	13	13	13	404	0	99	0	99	71	0	71	42	0	42
SECONDARY PUMPING	7	7	9	9	9	9	9	269	0	56	0	56	38	0	38	19	0	19
FORCE MAINS	1	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
STORAGE RESERVOIRS	1	1	1	1	2	2	2	47	0	9	0	9	6	0	6	3	0	3
RESERVOIR AER & CL	2	2	2	2	5	5	5	79	0	16	0	16	11	0	11	5	0	5
LAND PURCHASE & PREP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	1	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
DRAINAGE SYSTEMS	1	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
SLUDGE MANAGEMENT	1	1	1	1	1	1	1	43	0	12	0	12	9	0	9	6	0	6
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	23	23	28	29	34	34	0	1115		113	0	0	219	0	0	158	0	0
PW (BEGIN PER) 5 3/8%	58	107	120	132	145	145	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%	38	32	27	23	19	15	0		0	315	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%	54	102	114	127	140	139	0		0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%	27	21	17	13	10	[illegible]	0			0	0	0	219	0	0	0	0	0
PW (BEGIN PER) 10%	86	96	107	114	125	133	0			0	0	0	0	0	0	0	0	0
PW (1/72) 10%	15	10	7	5	3	2	0			0	0	0	0	0	0	158	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1											
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
AERATED LAGOONS	30	0	0	0	0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	20	20	20	20	20	20											
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	4	4	4	4	4	4	4	4	9	5	9	9	9	9	9											
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6											
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	9	9	9	9	9	9	9	9	14	14	17	17	22	22	22											
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	4	4	4	4	4	4	4	4	5	5	7	7	[illegible]	[illegible]	9											
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	[illegible]	3	3	4	4	5	4											
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	3	3	3	4	4	4											
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	2	2	2	3	3											
SLUDGE MANAGEMENT	15	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	4	4	4	4	4	4											
MISCELLANEOUS	33	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	1	2	2											
5 3/8% CRF		0	0	0	1	13	13	13	13	13	13	38	38	39	39	39	39	39	39	49	52	65	66	72	73	73											
7 % CRF		0	0	0	1	15	15	15	15	15	15	46	46	46	46	47	47	47	47	59	72	79	80	86	84	84											
10 % CRF		0	0	0	2	21	21	21	21	21	21	62	62	62	62	64	64	64	64	79	58	106	108	116	119	119											

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
CAPITAL RECOVERY FACTOR AT 5 3/8%																									
TOTAL ANNUAL CAPITAL	0	0	0	1	13	13	13	13	13	13	38	38	38	39	39	39	39	39	49	[illegible]	65	66	72	73	73
TOTAL ANNUAL O&M	14	16	17	18	19	8	8	8	8	8	8	17	17	17	17	17	18	19	23	23	28	29	34	34	35
TOTAL ANNUAL COSTS	14	16	17	19	32	21	21	21	21	21	46	55	55	55	56	56	57	58	72	[illegible]	93	95	106	107	108
CAPITAL RECOVERY FACTOR AT 7 %																									
TOTAL ANNUAL CAPITAL	0	0	0	1	15	15	15	15	15	15	46	46	46	46	47	47	47	47	59	72	79	80	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL O&M	14	16	17	18	19	8	8	8	8	8	8	17	17	17	17	17	18	19	23	23	28	29	34	34	35
TOTAL ANNUAL COSTS	14	16	17	19	34	23	23	23	23	23	54	63	63	63	64	64	65	66	82	95	107	109	[illegible]	122	123
CAPITAL RECOVERY FACTOR AT 10 %																									
TOTAL ANNUAL CAPITAL	0	0	0	[illegible]	21	21	21	21	21	21	62	62	62	62	64	64	64	64	79	[illegible]	106	108	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL O&M	14	16	17	[illegible]	[illegible]	8	8	8	8	8	8	17	17	17	17	17	18	19	23	23	28	29	34	34	35
TOTAL ANNUAL COSTS	14	16	17		[illegible]	29	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	79	79	79	81	81	81	83	102	[illegible]	134	137	[illegible]	153	154

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

AUBURN PLANT SIZE: 0.84 MGD SOIL-TYPE: CHILI APPLICATION RATE: 60 IN/YR AUBURN PLANT

- - - - - BASIC DESIGN DATA - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
POPULATION																									
DOMESTIC AND INDUSTRIAL Q				0.22	0.23	0.24	0.26	0.27	0.28	0.29	0.30	0.32	0.33	0.34	0.35	0.36	0.37	0.38	0.39	0.44	0.53	0.61	0.69	0.76	0.84
TREATMENT PLANT CAPACITY (MGD)					0.46						0.39								0.53	0.62	0.69	0.76	0.84	0.84	0.84
SLUDGE DISCHARGED (TPD)						0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.10	0.11	0.13	0.15	0.16	0.19
WINTER STORAGE (MG)												36	37	38	40	41	42	43	44	52	60	69	78	86	95
LAND AREA (ACRE)												72	74	76	78	80	83	85	87	103	119	137	155	170	188

PLAN C PLANT 9

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	50	27	24	1	23	22	0	22	19	0	19
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	336	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	336	17	221	5	215	195	2	192	156	0	156
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	19	0	0	0	0	210	0	0	0	0	0	0	0	0	0	0	0	0	0	0	185	0	0	0	210	0	605	252	247	25	227	213	9	204	167	2	165
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	63	0	0	0	0	0	0	0	63	0	0	0	0	63	0	189	63	68	5	63	54	2	51	36	0	36
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60	14	35	1	34	30	0	29	23	0	23
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	250	0	0	0	0	0	0	0	115	0	130	0	120	0	0	615	89	239	7	232	189	3	186	129	0	128
RESERVOIR AIR & L.	10	0	0	0	0	0	0	0	0	0	0	47	0	0	0	0	0	0	0	62	0	80	0	94	0	94	377	94	90	7	83	65	3	61	39	0	37
LAND PURCHASE & PREP	50	8	0	0	0	0	0	0	0	0	0	52	0	0	0	6	0	0	0	11	11	12	12	10	12	0	[illegible]	126	56	10	46	44	4	41	34	1	33
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	65	0	0	0	5	0	0	0	8	8	9	9	7	72	5	196	83	57	6	51	45	3	41	30	0	29
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	32	0	0	0	4	0	0	0	7	6	8	7	6	6	0	76	28	29	2	27	23	1	22	16	0	16
SLUDGE MANAGEMENT	19	0	0	0	0	59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	59	0	148	57	63	4	58	54	2	52	44	0	44
MISCELLANEOUS	33	0	0	0	0	21	0	0	0	0	0	9	0	0	0	0	0	0	0	1	20	1	1	1	25	0	79	0	31	0	31	26	0	26	20	0	20
TOTAL		8	0	0	25	290	0	0	0	336	0	576	0	0	0	15	0	0	0	267	260	240	29	263	447	94	2721	989	1167	71	1095	965	34	930	718	8	709
PW (1/72) 5 3/8%		8	0	0	21	235	0	0	0	221	0	340	0	0	0	7	0	0	0	104	78	55	5	36	46	8	0	0	1167	71	1095	0	0	0	0	0	0
PW (1/72) 7%		8	0	0	20	221	0	0	0	195	0	292	0	0	0	5	0	0	0	75	54	36	3	19	24	3	0	0	0	0	0	965	34	930	0	0	0
PW (1/72) 10%		8	0	0	18	198	0	0	0	156	0	222	0	0	0	3	0	0	0	48	29	16	1	7	7	0	0	0	0	0	0	0	0	0	718	8	709

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	24	26	28	31	33	1	1	1	2	2	2	2	2	2	2	2	2	2	2	3	4	4	5	5	6	280	0	152	0	152	137	0	137	118	0	118
SLUDGE FACILITIES	35	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	4	0	4	4	0	4	3	0	3
SEWERS	50	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	40	0	10	0	10	7	0	7	4	0	4
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	19	0	0	0	0	0	13	13	13	13	13	14	14	14	14	14	14	15	15	15	26	26	27	28	29	30	959	0	238	0	238	171	0	171	100	0	100
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	5	5	5	5	6	6	6	8	8	9	9	10	11	12	313	0	67	0	67	45	0	45	23	0	23
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	2	2	2	3	3	3	3	3	90	0	18	0	18	12	0	12	6	0	6
RESERVOIR AIR & L.	10	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	1	3	3	3	4	4	5	5	6	136	0	28	0	28	18	0	18	9	0	9
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	3	4	4	5	5	5	5	6	161	0	35	0	35	23	0	23	12	0	12
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
SLUDGE MANAGEMENT	19	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	43	0	12	0	12	9	0	9	6	0	6
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		25	27	29	32	34	16	16	16	19	18	19	32	32	32	32	34	36	36	39	41	57	58	62	64	0	2101	0	586	0	0	465	0	0	292	0	0
PW (BEGIN PERI) 5 3/8%		23	25	27	30	32	15	15	15	17	17	18	30	30	30	30	32	34	34	192	231	244	256	269	278	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%		23	24	24	25	26	11	11	10	11	10	10	17	16	15	14	14	14	14	23	45	56	45	36	29	0	0	0	416	0	0	0	0	0	0	0	0
PW (BEGIN PERI) 7%		23	25	27	29	31	14	14	14	16	16	17	29	29	29	29	31	33	33	184	271	233	246	261	265	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%		23	23	23	24	24	10	9	9	9	9	9	14	13	12	11	11	11	10	54	46	35	26	19	14	0	0	0	0	0	0	459	0	0	0	0	0
PW (BEGIN PERI) 10%		22	24	26	29	30	14	14	14	15	16	17	29	29	29	29	31	32	32	170	206	218	230	233	248	2	63	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%		22	22	21	21	[illegible]	9	8	7	7	6	6	10	9	8	7	7	7	6	30	22	15	9	6	4	0	0	0	0	0	0	0	0	0	101	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	0	0	0	1	[illegible]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1											
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SLUDGE FACILITIES	35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
SLUDGE FAC. EXP.	35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
SEWERS	50	0	0	0	0	0	0	0	0	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24											
SEWER EXPANSION	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
DETENTION BASINS	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
BASIN EXPANSION	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
TEMPORARY PUMPS	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
SHAFTS & TUNNELS	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
AERATED LAGOONS	19	0	0	0	0	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	29	29	29	29	29	29											
SECONDARY PUMPING	33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
FORCE MAINS	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
STORAGE RESERVOIRS	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
RESERVOIR AIR & L.	10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
LAND PURCHASE & PREP	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
IRRIGATION SYSTEMS	33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
DRAINAGE SYSTEMS	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
SLUDGE MANAGEMENT	19	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
MISCELLANEOUS	33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
5 3/8% CRF		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
7% CRF		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
10% CRF		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

CAPITAL RECOVERY FACTOR AT 5 3/8%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CAPITAL RECOVERY FACTOR AT 7%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CAPITAL RECOVERY FACTOR AT 10%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

SHALERSBORO PLANT   SIZE: [illegible]   SOIL-T PERMEABILITY   APPLICATION RATE: [illegible] IN/YR   THALERSBORO PLANT

- - - - - BASIC DESIGN DATA - - - - -

1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	
			0.71	0.73	0.76	0.78	0.81	0.84	0.87	0.90	0.92	0.95	0.98	1.01	1.04	1.07	1.09	1.12	1.27	1.42	1.58	1.73	1.86	2.06	POPULATION / DOMESTIC AND INDUSTRIAL
				1.27						1.12								1.42	1.58	1.73	1.86	2.00	2.00	2.00	TREATMENT PLANT CAPACITY (MGD)
					0.16	0.16	0.17	0.18	0.18	0.19	0.19	0.20	0.21	0.21	0.22	0.22	0.23	0.24	0.27	0.30	0.33	0.36	0.39	0.42	SLUDGE DISCHARGES (TPD)
											104	107	111	114	118	121	124	127	144	161	175	190	210	226	WINTER STORAGE (MG)
											206	213	219	227	233	239	244	251	265	318	354	389	417	448	LAND AREA (ACRES)

PLAN C   PLANT 10

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	556	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	35	0	0	0	0	400	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	35	0	0	0	0	0	0	0	0	0	0	94	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	160	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	580	0	0	0	0	0	0	0
RESERVOIR AREA C.L.	50	0	0	0	0	0	0	0	0	0	0	126	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	33	0	0	0	0	0	0	0	0	0	151	0	0	0	16	0	0	0
IRRIGATION SYSTEM	35	0	0	0	0	0	0	0	0	0	0	150	0	0	0	13	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	92	0	0	0	10	0	0	0
SLUDGE MANAGEMENT	15	0	0	0	0	84	0	0	0	0	0	3	0	0	0	0	0	0	0
MISCELLANEOUS	35	0	0	0	0	40	0	0	0	0	0	25	0	0	0	2	0	0	0
TOTAL		33	0	0	40	524	0	0	0	556	0	1338	0	0	0	41	0	0	0
PW (1/72) 5 3/8		33	0	0	36	424	0	0	0	365	0	792	0	0	0	20	0	0	0
PW (1/72) 7 %		33	0	0	32	395	0	0	0	323	0	679	0	0	0	15	0	0	0
PW (1/72) 10 %		33	0	0	30	357	0	0	0	259	0	516	0	0	0	10	0	0	0

ITEM	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	0	0	0	0	40	0	0	80	28	35	2	37	35	1	34	31	0	30
EXPAND TO LEVEL 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	0	0	0	0	0	0	0	556	111	365	8	356	323	4	319	259	1	258
SEWER EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	280	0	0	0	400	0	1080	455	456	36	413	386	17	368	311	4	306
SECONDARY PUMPING	94	0	0	0	0	94	0	282	93	102	7	94	80	3	77	56	0	53
FORCE MAINS	0	0	0	0	0	0	0	160	34	82	2	80	71	1	69	54	0	53
STORAGE RESERVOIRS	200	0	210	0	190	0	0	1160	184	484	14	469	389	7	382	271	1	265
RESERVOIR AREA C.L.	160	0	190	0	215	0	215	926	215	227	17	210	164	8	156	98	2	96
LAND PURCHASE & PREP	22	23	24	23	19	21	0	0	299	159	24	135	135	11	124	105	2	102
IRRIGATION SYSTEM	17	17	18	18	14	165	13	425	185	134	15	119	105	7	97	71	1	65
DRAINAGE SYSTEMS	13	14	14	14	11	13	0	181	52	77	4	72	62	2	60	44	0	43
SLUDGE MANAGEMENT	0	72	0	0	0	84	0	239	68	98	7	91	83	3	80	66	0	65
MISCELLANEOUS	3	31	3	3	2	50	0	159	0	65	0	65	55	0	55	42	0	42
TOTAL	509	436	459	58	491	827	226	5234	1746	2288	141	2146	1894	68	1825	1412	17	1394
PW (1/72) 5 3/8	358	133	106	10	67	86	18	0	0	2288	141	2146	0	0	0	0	0	0
PW (1/72) 7 %	150	51	68	6	37	45	5	0	0	0	0	0	1894	68	1825	0	0	0
PW (1/72) 10 %	91	46	31	2	13	14	2	0	0	0	0	0	0	0	0	1412	17	1394

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	2	2	2	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	35	0	0	0	0	0	25	25	25	25	25	25	29	29	29	29	30	31	32
SECONDARY PUMPING	35	0	0	0	0	0	0	0	0	0	0	0	5	5	5	5	5	5	5
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
RESERVOIR AREA C.L.	50	0	0	0	0	0	0	0	0	0	0	0	7	7	7	7	7	8	8
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEM	35	0	0	0	0	0	0	0	0	0	0	0	7	7	7	7	7	7	7
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2
SLUDGE MANAGEMENT	15	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
MISCELLANEOUS	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		2	2	2	3	3	30	31	31	33	33	33	61	61	62	63	63	65	67
PW (BEGIN PER) 5 3/8		1	1	1	2	2	28	29	29	31	31	31	57	57	58	59	59	61	63
PW (1/72) 5 3/8		1	1	1	2	2	21	21	20	20	19	19	32	30	29	29	27	26	26
PW (BEGIN PER) 7 %		1	1	1	2	2	28	28	28	30	30	32	57	57	[illegible]	[illegible]	58	60	62
PW (1/72) 7 %		1	1	1	2	2	19	19	19	17	16	15	27	25	24	22	21	23	19
PW (BEGIN PER) 10 %		1	1	1	2	2	27	28	28	29	32	29	55	55	[illegible]	[illegible]	57	59	60
PW (1/72) 10 %		1	1	1	2	1	16	17	14	13	12	11	19	17	16	15	13	12	12

ITEM	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	4	5	6	6	7	7	8	231	0	64	0	64	48	0	48	31	0	31
SLUDGE FACILITIES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	2	2	2	2	2	2	2	80	0	21	0	21	15	0	15	9	0	9
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	33	48	50	52	54	55	56	1870	0	469	0	469	336	0	336	197	0	197
SECONDARY PUMPING	13	13	14	15	16	17	17	475	0	96	0	96	63	0	63	31	0	31
FORCE MAINS	1	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
STORAGE RESERVOIRS	2	2	2	3	3	3	3	82	0	16	0	16	10	0	10	5	0	5
RESERVOIR AREA C.L.	8	9	10	11	12	12	13	361	0	78	0	78	53	0	53	28	0	28
LAND PURCHASE & PREP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEM	8	8	10	11	12	12	12	355	0	76	0	76	52	0	52	27	0	27
DRAINAGE SYSTEMS	2	2	2	2	3	3	3	89	0	19	0	19	13	0	13	7	0	7
SLUDGE MANAGEMENT	2	2	2	2	2	2	3	73	0	18	0	18	12	0	12	7	0	7
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	78	95	103	110	116	118	0	3657	0	672	0	0	614	0	0	349	0	0
PW (BEGIN PER) 5 3/8	368	426	456	482	459	505	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8	145	127	104	85	68	53	0	0	0	917	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7 %	373	405	436	464	484	442	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7 %	104	85	65	49	36	26	0	0	0	0	0	0	646	0	0	0	0	0
PW (BEGIN PER) 10 %	374	375	407	433	433	451	0	143	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10 %	58	42	28	18	11	7	0	0	0	0	0	0	0	0	0	349	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	35	0	0	0	0	33	30	36	30	30	30	30	30	30	30	30	30	30	30	30	51	51	51	51	51	51
SECONDARY PUMPING	35	0	0	0	0	0	0	0	0	0	0	7	7	7	7	7	7	7	7	14	14	14	14	14	14	14
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	40	40	40	40	40	40	40	40	54	54	69	69	83	83	83
RESERVOIR AREA C.L.	50	0	0	0	0	0	0	0	0	0	0	21	21	21	21	21	21	21	21	26	26	31	31	25	35	35
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	11	11	11	11	11	11	11	11	13	17	18	21	22	24	24
IRRIGATION SYSTEM	35	0	0	0	0	0	0	0	0	0	0	11	11	11	11	11	12	12	12	14	15	16	18	19	20	20
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	6	6	6	6	7	7	7	7	8	9	10	11	12	13	13
SLUDGE MANAGEMENT	15	0	0	0	0	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	17	17	17	17	33	33
MISCELLANEOUS	35	0	0	0	0	3	3	3	3	3	3	5	5	5	5	5	5	5	5	6	8	8	8	8	7	7
5 3/8 CRF		1	1	1	4	37	37	37	37	69	69	161	161	161	161	161	163	163	163	190	217	217	241	256	260	260
7 % CRF		2	2	2	5	44	44	44	44	84	84	196	196	196	196	196	197	197	197	229	262	262	290	309	314	314
10 % CRF		3	3	3	7	61	61	61	61	117	117	261	261	261	261	261	261	261	261	310	376	376	393	417	427	425

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

CAPITAL RECOVERY FACTOR AT 5 3/8%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	1	1	1	4	37	37	37	37	69	69	161	161	161	161	161	163	163	163	190	217	217	241	256	260	260
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL COSTS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CAPITAL RECOVERY FACTOR AT 7%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	2	2	2	5	44	44	44	44	84	84	196	196	196	196	196	197	197	197	229	262	262	290	309	314	314
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL COSTS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CAPITAL RECOVERY FACTOR AT 10%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	3	3	3	7	61	61	61	61	117	117	261	261	261	261	261	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL COSTS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

RAVENNA PLANT SIZE: 12.34(MGD) SOIL-TYPE:CHILI APPLICATION RATE: 66 IN/YR RAVENNA PLANT

- - - - - - BASIC DESIGN DATA - - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
POPULATION																									
DOMESTIC AND INDUSTRIAL Q				2.70	2.83	2.96	3.09	3.22	3.35	3.56	3.76	3.97	4.17	4.38	4.59	4.79	5.00	5.20	5.41	6.37	7.53	9.57	10.60	11.47	12.34
TREATMENT PLANT CAPACITY (MGD)					6.97						5.41								5.53	6.57	10.90	11.47	12.34	12.34	12.34
SLUDGE DISCHARGED (TPY)						0.62	0.65	0.68	0.70	0.75	0.79	0.83	0.88	0.92	0.97	1.04	1.05	1.09	1.14	1.44	1.80	2.03	2.23	2.42	2.59
WINTER STORAGE (MG)											425	449	471	495	519	541	565	588	611	788	964	1082	1192	1296	1394
LAND AREA (ACRE)											842	889	334	981	1028	1072	1120	1165	1212	1561	1911	2144	2374	2569	2764

PLAN C PLANT 11

- - - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	0	0	0	125	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	125	0	0	250	85	124	7	116	111	3	108	[illegible]	6	96
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	1476	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1476	247	1261	11	1250	1206	5	1199	[illegible]	[illegible]	[illegible]
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	35	0	0	0	0	1320	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1040	0	0	0	1220	0	[illegible]	1524	1321	123	1307	1299	59	1239	[illegible]	[illegible]	[illegible]
SECONDARY PUMPING	15	0	0	0	0	0	0	0	0	0	0	180	0	0	0	0	0	0	0	180	0	0	0	0	180	0	540	180	195	14	181	154	7	147	134	[illegible]	103
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	1243	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1243	295	734	24	709	629	11	618	476	[illegible]	475
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	1770	0	0	0	0	0	0	0	742	0	760	0	760	0	0	4072	1764	2416	244	2171	2289	64	2220	889	[illegible]	871
RESERVOIR AER & C.	10	0	0	0	0	0	0	0	0	0	0	925	0	0	0	0	0	0	0	815	0	900	0	890	0	990	4220	970	1052	80	972	756	38	718	448	[illegible]	438
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	751	0	0	0	55	0	0	0	232	273	155	153	130	130	0	2072	1835	725	148	576	577	71	505	385	[illegible]	376
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	720	0	0	0	50	0	0	0	325	145	134	132	112	832	50	2535	1071	781	82	698	602	39	562	390	[illegible]	388
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	415	0	0	0	75	0	0	0	142	142	93	79	79	79	0	1133	376	433	30	403	344	14	325	234	[illegible]	230
SLUDGE MANAGEMENT	19	0	0	0	0	223	0	0	0	0	0	0	0	0	0	0	0	0	0	3	139	0	0	0	223	0	591	222	244	17	226	210	8	202	171	7	165
MISCELLANEOUS	33	0	0	0	0	132	0	0	0	0	0	124	0	0	0	11	0	0	0	44	139	25	24	21	189	2	711	6	277	0	277	228	0	228	170	0	170
TOTAL		0	0	0	1601	1675	0	0	0	0	0	5725	0	0	0	191	0	0	0	2477	1834	2067	388	2217	2553	1042	20331	8468	8965	685	8285	7410	330	7079	5537	86	5452
PW (1/72) 5 3/8%		0	0	0	1369	1358	0	0	0	0	0	3369	0	0	0	91	0	0	0	966	550	477	69	343	310	84	0	0	8965	685	8283	0	0	0	0	0	0
PW (1/72) 7%		0	0	0	1306	1278	0	0	0	0	0	2906	0	0	0	74	0	0	0	733	386	310	41	168	162	40	0	0	0	0	0	7410	330	7079	0	0	0
PW (1/72) 10%		0	0	0	1202	1144	0	0	0	0	0	2209	0	0	0	50	0	0	0	445	205	142	16	59	50	10	0	0	0	0	0	0	0	0	5537	86	5452

- - - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	202	2?4	246	267	285	5	5	5	6	6	6	6	6	8	8	8	8	8	13	13	17	19	21	22	24	1853	0	1180	0	1180	1090	0	1090	967	0	967
SLUDGE FACILITIES	35	9	9	10	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	42	0	42	40	0	40	37	0	37
SEWERS	50	0	0	0	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	315	0	100	0	100	77	0	77	51	0	51
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	35	0	0	0	0	0	73	75	77	79	80	82	85	87	89	90	92	93	94	100	115	169	180	192	201	211	6152	0	1469	0	1469	1042	0	1042	604	0	604
SECONDARY PUMPING	15	0	0	0	0	0	0	0	0	0	0	0	31	32	33	34	36	37	38	45	57	65	71	77	81	86	2326	0	482	0	482	321	0	321	162	0	162
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	6	6	6	6	6	6	6	6	6	6	6	6	6	6	221	0	53	0	53	37	0	37	20	0	20
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	9	9	9	9	9	9	9	13	14	16	16	16	16	16	523	0	114	0	114	77	0	77	40	0	40
RESERVOIR AER & C.	10	0	0	0	0	0	0	0	0	0	0	0	32	32	32	33	33	33	34	48	49	64	65	75	76	78	2179	0	452	0	452	301	0	301	153	0	153
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	28	29	30	31	32	33	33	43	45	53	55	62	62	62	1861	0	396	0	396	266	0	266	136	0	136
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	7	7	8	8	8	8	8	10	12	13	15	16	17	17	479	0	100	0	100	67	0	67	34	0	34
SLUDGE MANAGEMENT	19	0	0	0	0	0	4	4	4	4	5	5	5	5	6	6	5	6	7	7	9	11	12	13	14	15	407	0	95	0	95	67	0	67	38	0	38
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		210	233	256	285	304	95	97	99	102	104	106	228	232	240	244	248	252	258	354	341	441	467	507	524	0	16367	0	4467	0	0	3368	0	0	2247	0	0
PW (INFLATION) 5 3/8%		193	221	242	277	292	90	92	94	97	98	100	216	219	227	231	235	239	244	1379	1674	1945	2079	2159	2241	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%		179	209	219	231	217	59	61	65	61	61	59	121	117	117	111	107	103	100	577	502	445	370	301	245	0	0	0	4452	0	0	0	0	0	0	0	0
PW (INFLATION) 7%		196	217	233	266	267	84	90	92	95	97	99	213	216	224	227	232	235	240	1321	1622	1861	2002	2134	2135	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%		174	203	238	217	214	61	60	57	55	52	53	101	96	93	88	84	79	76	351	338	279	214	162	117	0	0	0	0	0	0	3507	0	0	0	0	0
PW (INFLATION) 10%		192	212	232	249	[illegible]	44	88	90	92	96	96	207	210	217	221	226	228	234	1216	1463	1743	1868	1907	1999	22	645	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%		190	192	187	194	[illegible]	[illegible]	45	46	43	40	37	72	67	63	59	54	49	46	218	166	122	80	52	33	0	0	0	0	0	0	0	0	0	2316	0	0

- - - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	[illegible]	0	0	0	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9											
EXPAND TO LEVEL 1	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
[illegible]	[illegible]	[illegible]																																			

- - - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - - -

[illegible]

A-17

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

AURORA CENTRAL PLANT   SIZE: 2.98 MGD   SOIL-IT SPRAY/RUNNING   APPLICATION RATE: 40 IN/YR   AURORA CENTRAL PLANT

- - - - - BASIC DESIGN DATA - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
POPULATION																									
DOMESTIC AND INDUSTRIAL Q				0.410	0.448	0.486	0.524	0.562	0.600	0.672	0.744	0.816	0.888	0.960	1.032	1.104	1.176	1.248	1.320	1.925	1.733	2.02	2.31	2.65	2.98
TREATMENT PLANT CAPACITY (MGD)					1.52						1.32								1.73	2.02	2.31	2.65	2.98	2.98	2.98
SLUDGE DISCHARGED (TPD)						0.10	0.11	0.12	0.13	0.14	0.16	0.17	0.19	0.20	0.21	0.23	0.25	0.26	0.28	0.32	0.36	0.42	0.45	0.56	0.63
WINTER STORAGE (MG)											63	69	75	82	88	94	100	106	112	130	147	172	196	225	253
LAND AREA (ACRES)											111	122	133	143	154	165	176	186	197	228	259	302	345	396	445

PLAN C PLANT 12

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND
PLANTS	35	0	0	0	52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	52	0	0	104
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	960	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	960
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1080	0	0	0	0	0	0	1080
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	35	0	0	0	0	450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	415	0	0	0	450	0	1315
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	130	0	0	0	0	0	0	0	0	0	0	0	0	130	0	260
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	137	0	0	0	0	0	0	0	0	0	0	0	0	0	0	137
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	495	0	0	0	0	0	0	0	190	0	249	0	290	0	0	1224
RESERVOIR AER & CL	13	0	0	0	0	0	0	0	0	0	0	107	0	0	0	0	0	0	0	131	0	190	0	229	0	229	676
LAND PURCHASE & PREP	50	30	0	0	0	0	0	0	0	0	0	102	0	0	0	21	0	0	0	21	20	29	29	34	33	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	75	0	0	0	10	0	0	0	7	7	11	10	12	87	10	229
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	69	0	0	0	19	0	0	0	14	13	20	19	23	22	0	199
SLUDGE MANAGEMENT	39	0	0	0	0	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	67	0	0	0	87	0	221
MISCELLANEOUS	33	0	0	0	0	65	0	0	0	0	0	16	0	0	0	1	0	0	0	2	44	4	4	4	53	0	175
TOTAL		30	0	0	52	582	0	0	0	960	0	1131	0	0	0	53	0	0	0	1445	546	493	62	644	962	239	6740
PW (1/72) 5 3/8%		30	0	0	44	472	0	0	0	631	0	669	0	0	0	25	0	0	0	565	163	113	11	88	90	19	0
PW (1/72) 7%		30	0	0	42	444	0	0	0	558	0	576	0	0	0	20	0	0	0	427	115	73	6	48	47	9	0
PW (1/72) 10%		30	0	0	39	357	0	0	0	449	0	436	0	0	0	13	0	0	0	260	61	34	2	17	14	2	0

PLAN C PLANT 12

ITEM	TOTAL RESID	TOTAL PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	37	51	2	48	46	1	44	40	0	40
EXPAND TO LEVEL 1	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	0	0	0	0	0	0	0	0	0	0
SEWERS	191	631	15	616	558	7	551	448	1	446
SEWER EXPANSION	431	421	34	386	319	16	302	194	4	190
DETENTION BASINS	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	550	536	44	492	455	21	434	361	5	355
SECONDARY PUMPING	111	90	8	82	73	4	58	52	1	51
FORCE MAINS	33	81	2	78	69	1	68	52	0	52
STORAGE RESERVOIRS	576	464	46	417	367	22	344	250	4	244
RESERVOIR AER & CL	229	205	18	187	146	8	137	85	2	83
LAND PURCHASE & PREP	289	134	23	111	112	11	100	85	2	82
IRRIGATION SYSTEMS	107	69	8	61	54	4	50	36	1	35
DRAINAGE SYSTEMS	98	72	7	64	57	3	53	38	0	37
SLUDGE MANAGEMENT	85	93	6	86	81	3	77	66	0	65
MISCELLANEOUS	0	69	0	69	57	0	57	44	0	44
TOTAL	2737	2923	221	2701	2399	106	2292	1757	27	1730
PW (1/72) 5 3/8%	0	2923	221	2701	0	0	0	0	0	0
PW (1/72) 7%	0	0	0	0	2399	106	2292	0	0	0
PW (1/72) 10%	0	0	0	0	0	0	0	1757	27	1730

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND
PLANTS	35	30	36	41	56	64	1	1	1	2	2	2	2	2	3	3	3	3	3	4	5	6	7	8	9	10	458
SLUDGE FACILITIES	35	2	2	3	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
SEWERS	50	0	0	0	0	0	0	0	0	4	4	4	4	4	4	5	6	7	8	10	10	10	10	10	10	10	350
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	35	0	0	0	0	0	19	19	19	20	20	22	23	24	25	26	26	26	27	28	31	45	48	52	55	59	1661
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	12	12	13	13	14	14	14	15	16	17	18	20	22	24	647
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	37
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	3		4	4	5	5	5	5	151
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	6	6	6	6	6	7	7	8	9	11	12	14	15	16	399
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	6	6	6	6	6	6	6	7	7	10	10	12	12	12	342
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	2	2	2	67
SLUDGE MANAGEMENT	39	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	4	4	95
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		32	40	50	60	68	22	23	23	29	29	31	61	62	65	67	70	72	74	82	89	112	120	131	139	0	4222
PW (BEGIN PER) 5 3/8		30	37	47	56	64	20	21	21	27	27	29	57	55	61	63	55	68	70	363	428	497	533	576	604	0	0
PW (1/72) 5 3/8%		30	36	42	48	52	16	15	15	18	17	17	32	31	31	30	30	29	28	141	128	114	55	78	63	0	0
PW (BEGIN PER) 7%		29	37	46	56	63	20	21	21	27	27	28	57	57	60	62	65	67	69	348	465	475	514	559	576	0	0
PW (1/72) 7%		29	34	40	45	48	16	14	13	15	16	16	27	25	25	24	23	22	21	103	86	71	55	42	31	0	0
PW (BEGIN PER) 10%		29	36	45	54	61	19	20	22	26	26	28	55	56	58	60	63	65	67	321	375	445	479	500	539	4	131
PW (1/72) 10%		29	33	37	40	42	12	11	10	12	11	10	19	17	17	16	15	14	13	57	42	30	20	13	9	0	0

ITEM	TOTAL RESID	TOTAL PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	0	244	0	244	220	0	220	189	0	189
SLUDGE FACILITIES	0	12	0	12	11	0	11	10	0	10
SEWERS	0	81	0	81	56	0	56	30	0	30
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	394	0	394	279	0	279	161	0	161
SECONDARY PUMPING	0	141	0	141	96	0	96	50	0	50
FORCE MAINS	0	8	0	8	6	0	6	3	0	3
STORAGE RESERVOIRS	0	32	0	32	22	0	22	11	0	11
RESERVOIR AER & CL	0	81	0	81	54	0	54	27	0	27
LAND PURCHASE & PREP	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	0	71	0	71	48	0	48	24	0	24
DRAINAGE SYSTEMS	0	14	0	14	9	0	9	5	0	5
SLUDGE MANAGEMENT	0	21	0	21	14	0	14	8	0	8
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0
TOTAL	0	1106	0	0	819	0	0	523	0	0
PW (BEGIN PER) 5 3/8	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%	0	1167	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%	0	0	0	0	848	0	0	0	0	0
PW (BEGIN PER) 10%	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%	0	0	0	0	0	0	0	539	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND
PLANTS	35	0	0	0	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
SEWERS	50	0	0	0	0	0	0	0	0	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	77	77	77	77	77	77	77	
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
AERATED LAGOONS	35	0	0	0	0	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	64	64	64	64	64	64	
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	35	35	35	35	35	35	35	35	49	49	67	67	88	88	88	
RESERVOIR AER & CL	13	0	0	0	0	0	0	0	0	0	0	17	17	17	17	17	17	17	17	21	21	30	30	38	38	38	
LAND PURCHASE & PREP	50	2	2	2	2	2	2	2	2	2	2	9	9	9	9	11	11	11	11	12	13	16	18	20	22	22	
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	5	5	5	5	6	5	6	6	7	7	8	9	10	11	11	
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	4	4	4	4	6	6	6	6	7	8	9	11	12	14	14	
SLUDGE MANAGEMENT	39	0	0	0	0	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	10	10	10	10	10	10	
MISCELLANEOUS	33	0	0	0	0	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	5	6	8	9	6	8	
5 3/8% CRF		1	1	1	5	41	41	41	41	96	96	176	176	176	176	177	177	177	177	257	251	317	321	347	353	353	
7 % CRF		2	2	2	6	49	49	49	49	119	119	211	211	211	211	215	215	215	215	314	395	386	390	421	429	429	
10 % CRF		3	3	3	8	67	67	67	67	166	166	289	289	289	288	294	294	294	294	431	487	528	534	575	586	595	

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
CAPITAL RECOVERY FACTOR AT 5 3/8%																									
TOTAL ANNUAL CAPITAL	1	1	1	5	41	41	41	41	96	96	176	176	176	176	177	177	177	177	257	291	317	321	347	353	353
TOTAL ANNUAL O&M	32	40	50	60	64	22	23	23	29	29	31	61	62	65	67	70	72	74	82	89	112	120	131	139	143
TOTAL ANNUAL COSTS	33	41	51	65	105	63	64	64	125	125	205	235	236	239	244	247	249	251	339	380	429	441	478	492	496
CAPITAL RECOVERY FACTOR AT 7 %																									
TOTAL ANNUAL CAPITAL	2	2	2	6	49	49	49	49	119	119	211	211	211	211	215	215	215	215	314	395	386	390	421	429	429
TOTAL ANNUAL O&M	32	40	50	60	68	22	23	23	29	29	31	61	62	65	67	70	72	74	82	89	112	120	131	139	143
TOTAL ANNUAL COSTS	34	42	52	66	117	71	72	72	148	148	242	272	273	276	282	285	287	289	396	484	498	510	552	568	572
CAPITAL RECOVERY FACTOR AT 10 %																									
TOTAL ANNUAL CAPITAL	3	3	3	8	67	67	67	67	166	166	289	289	289	289	294	294	294	294	431	487	528	534	575	586	595
TOTAL ANNUAL O&M	32	40	50	60	68	22	23	23	29	29	31	61	62	65	67	70	72	74	82	89	112	120	131	139	143
TOTAL ANNUAL COSTS	35	43	53	68	135	89	90	90	195	195	320	350	351	354	361	364	366	368	513	576	640	654	706	725	738

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

FAIRMOUNT ROAD PLANT SIZE: 3.40(MGD) SOIL-E WPE(CHILI APPLICATION RATE: 6" IN/YR FAIRMOUNT ROAD PLANT

- - - - - - BASIC DESIGN DATA - - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
POPULATION																									
DOMESTIC AND INDUSTRIAL C				0.31	0.35	0.40	0.45	0.49	0.54	0.64	0.74	0.84	0.94	1.05	1.15	1.25	1.35	1.45	1.55	1.85	2.14	2.47	2.80	3.10	3.40
TREATMENT PLANT CAPACITY (MGD)					1.85						1.55								2.14	2.47	2.80	3.10	3.40	3.40	3.40
SLUDGE DISCHARGE (TPD)						0.08	0.10	0.10	0.11	0.13	0.14	0.18	0.20	0.22	0.24	0.26	0.28	0.31	0.33	0.35	0.45	0.52	0.59	0.65	0.71
WINTER STORAGE (MG)												95	106	119	130	141	153	164	175	209	242	275	316	350	384
LAND AREA (ACRE)												188	211	235	258	280	302	325	347	414	479	553	627	694	762

PLAN C PLANT 13

- - - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	0	0	0	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	720	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	520	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	139	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	385	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	715	0	0	0	0	0	0	0
RESERVOIR AERATION	20	0	0	0	0	0	0	0	0	0	0	162	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	173	0	0	0	57	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	161	0	0	0	45	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	106	0	0	0	16	0	0	0
SLUDGE MANAGEMENT	39	0	0	0	0	95	0	0	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	33	0	0	0	0	52	0	0	0	0	0	28	0	0	0	9	0	0	0
TOTAL		0	0	0	776	667	0	0	0	0	0	1867	0	0	0	147	0	0	0
PW (1/72) 5 3/8 %		0	0	0	663	540	0	0	0	0	0	1105	0	0	0	70	0	0	0
PW (1/72) 7 %		0	0	0	633	509	0	0	0	0	0	948	0	0	0	57	0	0	0
PW (1/72) 10 %		0	0	0	582	455	0	0	0	0	0	720	0	0	0	38	0	0	0

	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	0	0	0	0	56	0	0	112	35	55	3	52	49	1	48	43	0	43
EXPAND TO LEVEL 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	0	0	0	0	0	0	0	720	72	615	5	609	587	2	584	540	0	540
SEWER EXPANSION	458	0	0	0	0	0	0	498	139	194	16	178	147	7	139	49	1	47
DETENTION BASINS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	405	0	0	0	520	0	1445	539	557	43	554	510	21	489	409	5	403
SECONDARY PUMPING	139	0	0	0	0	139	0	417	135	151	11	139	119	5	113	81	1	75
FORCE MAINS	0	0	0	0	0	0	0	385	92	227	7	220	195	3	191	148	0	147
STORAGE RESERVOIRS	295	0	335	0	325	0	0	1670	1124	660	91	569	525	43	481	367	11	349
RESERVOIR AERATION	218	0	292	0	340	0	140	1362	340	320	27	292	228	13	214	133	3	130
LAND PURCHASE & PREP	44	44	48	48	45	45	0	[illegible]	504	190	40	149	150	19	130	101	5	96
IRRIGATION SYSTEMS	49	48	37	36	33	155	45	649	280	194	22	171	148	10	137	94	2	94
DRAINAGE SYSTEMS	27	26	30	29	28	27	0	337	109	115	8	107	91	4	87	61	1	60
SLUDGE MANAGEMENT	0	49	0	0	0	95	0	239	93	101	7	94	88	3	84	71	0	71
MISCELLANEOUS	7	48	7	7	7	67	2	234	0	91	0	91	75	0	75	57	0	57
TOTAL	1277	420	739	120	834	1088	387	8014	3530	3516	285	3230	2918	137	2780	2197	35	2162
PW (1/72) 5 3/8 %	499	186	170	21	114	124	31	0	0	3516	285	3230	0	0	0	0	0	0
PW (1/72) 7 %	377	130	110	12	63	59	15	0	0	0	0	0	2918	137	2780	0	0	0
PW (1/72) 10 %	229	65	50	5	22	14	3	0	0	0	0	0	0	0	0	2197	35	2162

- - - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	9	19	29	40	50	1	1	1	1	1	1	1	1	3	3	3	3	3
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	0	20	20	21	22	22	23	24	26	27	29	30	31	32
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	12	12	13	13	14	14	15
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	4	4	4	4	4	4	4
RESERVOIR AERATION	20	0	0	0	0	0	0	0	0	0	0	0	9	9	9	9	9	9	10
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	10	10	10	11	11	11	11
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	2	2
SLUDGE MANAGEMENT	39	0	0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		9	14	29	43	53	27	27	28	29	29	30	70	72	77	81	83	86	87
PW [illegible] 5 3/8 %		9	14	27	40	50	25	25	26	27	27	28	66	68	73	76	78	79	82
PW [illegible]		9	17	24	36	40	19	18	18	18	17	16	37	36	36	36	35	34	33
PW [illegible]		9	17	27	42	46	25	25	26	27	27	28	65	67	71	75	77	78	81
PW [illegible]		9	15	23	32	37	[illegible]	16	16	17	16	16	31	25	29	27	28	26	25
PW [illegible] 10 %		9	17	29	39	48	24	24	25	26	26	27	63	65	69	73	75	76	79
PW [illegible]		9	15	21	25	32	15	13	13	12	11	10	22	20	20	19	19	16	15

	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	5	6	7	8	9	10	11	395	0	171	0	171	148	0	148	121	0	121
SLUDGE FACILITIES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	6	6	6	6	6	6	6	225	0	60	0	60	44	0	44	27	0	27
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	33	38	53	58	61	64	67	1932	0	453	0	453	319	0	319	182	0	182
SECONDARY PUMPING	22	24	25	27	29	31	33	508	0	190	0	190	127	0	127	64	0	64
FORCE MAINS	2	2	2	2	2	2	2	76	0	17	0	17	12	0	12	6	0	6
STORAGE RESERVOIRS	5	5	7	7	7	7	7	223	0	48	0	48	32	0	32	16	0	16
RESERVOIR AERATION	13	13	17	19	19	23	21	594	0	122	0	122	82	0	82	41	0	41
LAND PURCHASE & PREP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	13	14	16	18	19	19	19	575	0	124	0	124	84	0	84	43	0	43
DRAINAGE SYSTEMS	3	3	3	4	4	4	5	116	0	23	0	23	15	0	15	7	0	7
SLUDGE MANAGEMENT	2	2	3	3	4	4	4	104	0	24	0	24	17	0	17	9	0	9
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	107	116	144	157	165	172	0	5144	0	1238	0	0	983	0	0	522	0	0
PW [illegible] 5 3/8 %	475	556	642	687	717	741	0	0	0	0	0	0	0	0	0	0	0	0
PW [illegible]	185	167	148	122	98	77	0	0	0	1286	0	0	0	0	0	0	0	0
PW [illegible]	455	532	615	682	656	727	0	0	0	0	0	0	0	0	0	0	0	0
PW [illegible]	134	112	92	70	57	48	0	0	0	0	0	0	918	0	0	0	0	0
PW [illegible] 10 %	423	493	571	617	622	661	5	159	0	[illegible]	0	0	0	0	0	0	0	0
PW [illegible]	75	44	39	26	16	11	0	0	0	0	0	0	0	0	0	442	0	0

- - - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	[illegible]	[illegible]	[illegible]	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4											
[illegible]	25	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
[illegible]	25	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											

- - - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - - -

CAPITAL RECOVERY RATE AT [illegible]

CAPITAL RECOVERY RATE AT [illegible]

CAPITAL RECOVERY RATE AT [illegible]

A-19

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

FOWLER'S MILL PLANT   SIZE: 1.98(MGD)   SOIL-T PRECHELL   APPLICATION RATE: 60 IN/YR   FOWLER'S MILL PLANT

- - - - - BASIC DESIGN DATA - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
POPULATION																									
DOMESTIC AND INDUSTRIAL				0.51	0.55	0.57	0.59	0.62	0.64	0.67	0.67	0.73	0.75	0.78	0.80	0.82	0.84	0.86	0.88	1.01	1.14	1.34	1.56	1.76	1.98
TREATMENT PLANT CAPACITY (MGD)					1.01						0.98								1.16	1.34	1.54	1.76	1.98	1.98	1.98
SLUDGE DISCHARGED (TPD)						0.12	0.12	0.13	0.13	0.14	0.15	0.15	0.16	0.16	0.17	0.17	0.16	0.18	0.19	0.21	0.24	0.28	0.32	0.37	0.42
WINTER STORAGE (MG)												82	85	88	90	93	95	97	99	114	129	153	174	199	224
LAND AREA (ACRES)												164	168	175	179	184	189	193	197	226	259	300	345	396	444

PLAN C PLANT 14

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	979	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	335	0	0	0	345	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	84	0	0	0	0	0	0	0	84	0	0	0	0	84	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	105	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	465	0	0	0	0	0	0	0	185	0	240	0	250	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	127	0	170	0	215	0	215
LAND PURCHASE & PREP	50	20	0	0	0	0	0	0	0	0	0	128	0	0	0	12	0	0	0	19	19	30	30	33	33	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	116	0	0	0	12	0	0	0	35	15	23	23	25	141	12
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	73	0	0	0	7	0	0	0	12	12	19	18	20	20	0
SLUDGE MANAGEMENT	39	0	0	0	0	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	80	0
MISCELLANEOUS	33	0	0	0	0	36	0	0	0	0	0	20	0	0	0	2	0	0	0	3	36	4	4	5	45	0
TOTAL		20	0	0	1019	459	0	0	0	0	0	1086	0	0	0	35	0	0	0	445	457	486	75	593	748	227
PW (1/72) 5 3/8%		20	0	0	871	372	0	0	0	0	0	642	0	0	0	15	0	0	0	173	137	112	13	81	78	18
PW (1/72) 7 %		20	0	0	931	350	0	0	0	0	0	551	0	0	0	12	0	0	0	131	96	72	8	45	41	8
PW (1/72) 10 %		20	0	0	765	313	0	0	0	0	0	419	0	0	0	8	0	0	0	80	51	33	3	16	12	2

	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	40	28	39	2	37	35	1	34	31	0	30
EXPAND TO LEVEL 1	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	0	0	0	0	0	0	0	0	0	0	0
SEWERS	979	97	837	7	829	798	3	795	735	0	734
SEWER EXPANSION	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	1025	427	416	34	381	352	16	336	279	4	274
SECONDARY PUMPING	252	84	91	6	84	72	3	68	44	0	48
FORCE MAINS	105	25	42	2	40	53	0	52	40	0	40
STORAGE RESERVOIRS	1140	301	434	24	410	343	11	332	234	3	231
RESERVOIR AER & CL	827	215	194	17	177	138	8	130	81	2	78
LAND PURCHASE & PREP	0	304	134	24	110	111	11	99	82	3	79
IRRIGATION SYSTEMS	382	176	113	14	99	87	6	80	58	1	56
DRAINAGE SYSTEMS	181	49	67	5	61	53	2	50	36	0	35
SLUDGE MANAGEMENT	200	78	85	6	78	73	3	70	60	0	59
MISCELLANEOUS	153	0	59	0	59	49	0	49	37	0	37
TOTAL	5324	1804	2536	146	2390	2170	70	2099	1725	18	1707
PW (1/72) 5 3/8%	0	0	2536	146	2390	0	0	0	0	0	0
PW (1/72) 7 %	0	0	0	0	0	2170	70	2099	0	0	0
PW (1/72) 10 %	0	0	0	0	0	0	0	0	1725	18	1707

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	61	66	71	77	82	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	5	6	7	8
SLUDGE FACILITIES	35	4	4	4	5	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	0	16	16	16	16	16	17	17	17	18	18	19	19	20	20	32	34	36	38	40	42
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	9	9	10	10	10	10	10	13	14	15	16	17	18	19
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	3	3	4	4	5	6	6
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	5	5	5	5	6	6	6	7	8	9	10	12	12	12
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	6	6	6	6	6	6	6	7	7	9	9	10	11	12
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	3	3	3
SLUDGE MANAGEMENT	39	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	3
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		65	70	75	86	92	24	24	24	24	24	25	50	50	53	53	55	55	56	63	77	87	92	101	107	0
PW (BEGIN PER) 5 3/8		51	66	71	81	87	22	22	22	22	22	23	47	47	50	50	52	52	53	299	351	381	409	444	462	0
PW (1/72) 5 3/8%		61	63	64	69	70	17	16	15	14	14	16	26	25	25	24	23	22	21	338	105	88	72	60	48	0
PW (BEGIN PER) 7%		60	65	70	80	85	22	22	22	22	22	23	46	46	49	49	51	51	52	287	336	364	396	431	461	0
PW (1/72) 7%		60	62	61	65	65	15	14	13	13	12	11	22	20	20	19	18	17	16	85	70	54	42	32	24	0
PW (BEGIN PER) 10%		59	63	68	78	81	21	21	21	21	21	22	45	45	48	48	50	49	50	224	311	343	368	385	412	3
PW (1/72) 10%		59	57	56	58	57	13	12	11	10	9	8	15	14	13	12	11	10	10	47	34	23	15	10	7	0

	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	528	0	343	0	343	317	0	317	282	0	282
SLUDGE FACILITIES	23	0	19	0	19	18	0	18	17	0	17
SEWERS	190	0	57	0	57	46	0	44	29	0	29
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	1280	0	310	0	310	220	0	220	124	0	128
SECONDARY PUMPING	533	0	115	0	115	78	0	78	40	0	40
FORCE MAINS	37	0	8	0	8	6	0	6	3	0	3
STORAGE RESERVOIRS	139	0	27	0	27	18	0	18	9	0	9
RESERVOIR AER & CL	333	0	68	0	68	46	0	46	23	0	23
LAND PURCHASE & PREP	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	312	0	67	0	67	45	0	45	23	0	23
DRAINAGE SYSTEMS	77	0	15	0	15	10	0	10	5	0	5
SLUDGE MANAGEMENT	43	0	15	0	15	11	0	11	6	0	6
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0	0
TOTAL	3505	0	1091	0	0	818	0	0	570	0	0
PW (BEGIN PER) 5 3/8	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%	0	0	1085	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%	0	0	0	0	0	841	0	0	0	0	0
PW (BEGIN PER) 10%	100	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%	0	0	0	0	0	0	0	0	583	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	51	51	51	51	51	51
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	6	6	6	6	6	6	6	6	13	13	13	13	13	13	13
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	33	33	33	33	33	33	33	33	46	46	63	63	82	82	82
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	16	16	16	16	16	16	16	16	21	21	28	28	35	35	35
LAND PURCHASE & PREP	50	1	1	1	1	1	1	1	1	1	1	10	10	10	10	11	11	11	11	12	14	16	18	20	23	23
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	9	9	9	9	9	9	9	9	11	12	14	15	17	19	19
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	5	5	5	5	5	5	5	5	6	7	8	10	11	13	13
SLUDGE MANAGEMENT	39	0	0	0	0	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	9	9	9	9	9
MISCELLANEOUS	33	0	0	0	0	2	2	2	2	2	2	4	4	4	4	4	4	4	4	4	7	7	8	5	7	7
5 3/8% CRF		1	1	1	60	89	89	89	89	89	89	163	163	163	163	165	165	165	165	199	217	242	247	271	278	277
7 % CRF		1	1	1	75	109	109	109	109	109	109	198	198	198	198	201	201	201	201	229	263	293	299	329	336	335
10 % CRF		2	2	2	105	151	151	151	151	151	151	270	270	270	270	274	274	274	274	311	358	358	406	445	455	455

TOTAL EXPEND | TOTAL RESID | PRESENT WORTH AT 5 3/8% EXPEND RESID NET | PRESENT WORTH AT 7% EXPEND RESID NET | PRESENT WORTH AT 10% EXPEND RESID NET

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
CAPITAL RECOVERY FACTOR AT 5 3/8%																									
TOTAL ANNUAL CAPITAL	1	1	1	60	89	89	89	89	89	89	163	163	163	163	165	165	165	165	199	217	242	247	271	278	277
TOTAL ANNUAL O&M	65	70	75	86	92	24	24	24	24	24	25	50	50	53	53	55	55	56	63	77	87	92	101	107	110
TOTAL ANNUAL COSTS	66	71	76	146	181	113	113	113	113	113	188	213	213	216	218	220	220	221	262	294	329	339	372	385	387
CAPITAL RECOVERY FACTOR AT 7 %																									
TOTAL ANNUAL CAPITAL	1	1	1	75	109	109	109	109	109	109	198	198	198	198	201	201	201	201	229	263	293	299	329	336	335
TOTAL ANNUAL O&M	65	70	75	86	92	24	24	24	24	24	25	50	50	53	53	55	55	56	63	77	87	92	101	107	110
TOTAL ANNUAL COSTS	66	71	76	161	201	133	133	133	133	133	223	248	248	251	254	256	256	257	292	340	380	391	430	443	445
CAPITAL RECOVERY FACTOR AT 10 %																									
TOTAL ANNUAL CAPITAL	2	2	2	105	151	151	151	151	151	151	270	270	270	270	274	274	274	274	311	358	358	406	445	455	455
TOTAL ANNUAL O&M	65	70	75	86	92	24	24	24	24	24	25	50	50	53	53	55	55	56	63	77	87	92	101	107	110
TOTAL ANNUAL COSTS	67	72	77	191	243	175	175	175	175	175	295	320	320	323	327	329	329	330	374	435	445	498	546	562	565

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

NEWBURY TOWNSHIP PLANT SIZE: (LISTINGS) SOIL-T PRETREATMENT APPLICATION RATE: 40 IN/YR NEWBURY TOWNSHIP PLANT

- - - - - BASIC DESIGN DATA - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
POPULATION																									
DOMESTIC AND INDUSTRIAL G				0.41	0.42	0.44	0.46	0.48	0.50	0.52	0.54	0.56	0.58	0.60	0.62	0.64	0.65	0.67	0.69	0.76	0.90	1.02	1.13	1.35	1.54
TREATMENT PLANT CAPACITY (MGD)					0.79						0.69								0.90	1.02	1.13	1.33	1.54	1.54	1.54
SLUDGE DISCHARGED (TPD)						0.09	0.10	0.10	0.10	0.11	0.11	0.12	0.12	0.13	0.13	0.13	0.14	0.14	0.15	0.17	0.19	0.21	0.24	0.28	0.32
WINTER STORAGE (MG)												48	49	51	53	54	55	57	59	67	77	87	96	113	131
LAND AREA (ACRE)												84	87	90	93	96	97	100	103	118	134	152	165	199	230

PLAN C PLANT 15

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	0	0	0	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	295	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	15	0	0	0	0	0	0	0	0	0	0	80	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	90	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	320	0	0	0	0	0	0	0
RESERVOIR AER & LC	10	0	0	0	0	0	0	0	0	0	0	62	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	15	0	0	0	0	0	0	0	0	0	62	0	0	0	7	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	45	0	0	0	5	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	42	0	0	0	5	0	0	0
SLUDGE MANAGEMENT	39	0	0	0	0	81	0	0	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	33	0	0	0	0	29	0	0	0	0	0	9	0	0	0	1	0	0	0
TOTAL		15	0	0	34	405	0	0	0	0	0	710	0	0	0	18	0	0	0
PW (1/72) 5 3/8%		15	0	0	29	328	0	0	0	0	0	420	0	0	0	8	0	0	0
PW (1/72) 7%		15	0	0	27	309	0	0	0	0	0	360	0	0	0	6	0	0	0
PW (1/72) 10%		15	0	0	25	276	0	0	0	0	0	274	0	0	0	4	0	0	0

ITEM	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	0	0	0	0	34	0	0	68	24	33	1	31	30	0	29	26	0	26
EXPAND TO LEVEL 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	715	0	0	0	0	0	0	715	285	270	25	255	211	11	200	124	2	125
SEWER EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	285	0	0	0	295	0	875	365	355	29	326	301	14	287	238	3	234
SECONDARY PUMPING	80	0	0	0	0	80	0	240	80	86	6	80	68	3	65	46	0	45
FORCE MAINS	0	0	0	0	0	0	0	90	22	53	1	51	45	0	44	34	0	34
STORAGE RESERVOIRS	135	0	140	0	220	0	0	815	112	304	9	295	240	4	235	163	1	162
RESERVOIR AER & LC	80	0	98	0	130	0	130	500	150	118	10	108	84	5	79	49	1	48
LAND PURCHASE & PREP	10	11	12	11	20	21	0	0	154	71	12	59	60	6	54	44	1	44
IRRIGATION SYSTEMS	4	4	4	4	7	53	5	131	60	40	6	35	31	2	29	21	0	20
DRAINAGE SYSTEMS	7	7	8	8	14	14	0	105	60	38	3	35	30	1	29	21	0	20
SLUDGE MANAGEMENT	0	33	0	0	0	81	0	195	77	84	6	77	73	3	70	60	0	59
MISCELLANEOUS	1	30	2	1	2	34	0	108	0	42	0	42	35	0	35	27	0	27
TOTAL	1032	370	263	24	427	578	135	3842	1349	1510	109	1400	1214	52	1161	865	13	851
PW (1/72) 5 3/8%	402	111	60	4	58	60	10	0	0	1510	109	1400	0	0	0	0	0	0
PW (1/72) 7%	305	78	39	2	32	31	5	0	0	0	0	0	1214	52	1161	0	0	0
PW (1/72) 10%	185	41	18	1	11	9	1	0	0	0	0	0	0	0	0	865	13	851

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	48	52	56	60	64	2	2	2	2	2	2	2	2	3	3	3	3	3
SLUDGE FACILITIES	35	3	3	3	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	35	0	0	0	0	0	14	14	14	15	15	15	15	16	16	17	17	17	18
SECONDARY PUMPING	15	0	0	0	0	0	0	0	0	0	0	0	5	5	6	6	7	7	8
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2
RESERVOIR AER & LC	10	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	3
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	3
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
SLUDGE MANAGEMENT	39	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		51	55	59	64	69	18	18	18	19	19	19	34	35	37	38	39	39	41
PW (BEGIN PER) 5 3/8%		48	52	55	60	64	17	17	17	18	18	18	32	33	35	36	37	37	38
PW (1/72) 5 3/8%		48	49	53	51	52	13	12	11	11	11	10	18	17	17	17	16	16	15
PW (BEGIN PER) 7%		47	51	55	56	61	16	16	16	17	17	17	31	32	34	35	36	36	38
PW (1/72) 7%		47	48	48	46	49	13	11	10	10	9	9	15	14	14	13	13	12	12
PW (BEGIN PER) 10%		46	43	53	58	61	16	16	16	17	17	17	30	31	33	34	35	35	37
PW (1/72) 10%		46	45	44	43	42	10	9	8	8	7	6	10	10	9	8	7	7	7

ITEM	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	3	3	4	5	6	7	8	451	0	277	0	277	255	0	255	225	0	225
SLUDGE FACILITIES	0	0	0	0	0	0	0	17	0	14	0	14	13	0	13	12	0	12
SEWERS	3	3	3	3	3	3	3	90	0	17	0	17	11	0	11	5	0	5
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	18	18	27	29	31	32	34	1013	0	250	0	250	179	0	179	106	0	106
SECONDARY PUMPING	13	14	14	15	15	16	16	475	0	100	0	100	67	0	67	33	0	33
FORCE MAINS	1	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
STORAGE RESERVOIRS	2	2	3	3	4	4	4	104	0	21	0	21	14	0	14	7	0	7
RESERVOIR AER & LC	4	5	6	7	8	8	8	211	0	42	0	42	27	0	27	14	0	14
LAND PURCHASE & PREP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	4	4	5	6	7	7	7	186	0	38	0	38	25	0	25	13	0	13
DRAINAGE SYSTEMS	1	1	1	1	1	2	2	42	0	9	0	9	6	0	6	3	0	3
SLUDGE MANAGEMENT	1	1	1	1	2	2	2	53	0	13	0	13	10	0	10	6	0	6
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	51	53	67	73	80	84	0	2143	0	795	0	0	618	0	0	431	0	0
PW (BEGIN PER) 5 3/8%	222	257	300	324	350	360	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%	86	77	69	57	47	37	0	0	0	820	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%	213	245	287	312	339	363	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%	63	51	43	33	25	19	0	0	0	0	0	0	635	0	0	0	0	0
PW (BEGIN PER) 10%	156	227	268	291	303	321	2	63	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%	35	25	18	12	8	5	0	0	0	0	0	0	0	0	0	640	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	51	51	51	51	51	51	51
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	43	43	43	43	43	43
SECONDARY PUMPING	15	0	0	0	0	0	0	0	0	0	0	6	6	6	6	6	6	6	6	12	12	12	12	12	12	12
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	4	6	6	6	6	6	6	6	6	6	5	6	6	6	6
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	23	23	23	23	23	23	23	23	32	32	42	42	58	58	58
RESERVOIR AER & LC	10	0	0	0	0	0	0	0	0	0	0	10	10	10	10	10	10	10	10	13	13	16	16	21	21	21
LAND PURCHASE & PREP	50	1	1	1	1	1	1	1	1	1	1	5	5	5	5	6	6	6	6	6	7	7	9	10	12	12
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	3	3	4	4	4	5	5	5	6
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	3	3	3	4	4	5	6	7	7
SLUDGE MANAGEMENT	15	0	0	0	0	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
MISCELLANEOUS	15	0	0	0	0	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	5	5	5	5	5	5
5 3/8% CRF		0	0	0	3	28	28	28	28	28	28	76	76	76	76	77	77	77	77	136	155	171	173	151	155	155
7 % CRF		0	0	0	3	36	36	36	36	36	36	91	91	91	91	93	93	93	93	165	193	229	235	231	237	236
10 % CRF		0	0	0	4	46	46	46	46	46	46	123	123	123	123	125	125	125	125	229	263	283	285	315	322	322

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

CAPITAL RECOVERY FACTOR AT 5 3/8%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL			0	3	28	28	28	28	28	28	76	76	76	76	77	77	77	77	136	155	171	173	151	155	155
TOTAL ANNUAL O&M	51	55	59	64	64	18	18	18	19	19	19	34	35	37	38	39	39	41	52	57	67	73	82	84	85
TOTAL ANNUAL	51	55	59	67	92	46	46	46	47	47	95	110	111	113	115	116	116	118	187	212	238	246	231	239	240

CAPITAL RECOVERY FACTOR AT 7%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL				3	36	36	36	36	36	36	91	91	91	91	93	93	93	93	165	193	229	235	231	237	236
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	52	53	53	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CAPITAL RECOVERY FACTOR AT 10%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	[illegible]	[illegible]	[illegible]	[illegible]	46	46	46	46	46	46	123	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

CHAGRIN FALLS PLANT SIZE 7.87 MGD SOIL-TYPE: MAHONING APPLICATION RATE 40 IN/YR CHAGRIN FALLS PLANT

- - - - - BASIC DESIGN DATA - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
POPULATION																									
DOMESTIC AND INDUSTRIAL -				1.49	1.58	1.68	1.78	1.88	1.98	2.17	2.37	2.56	2.75	2.94	3.14	3.33	3.52	3.71	3.91	4.55	5.19	5.89	6.60	7.23	7.87
TREATMENT PLANT CAPACITY (MGD)					4.55						3.91								5.19	5.85	6.63	7.23	7.87	7.87	7.87
SLUDGE DISCHARGED (TPD)						0.35	0.37	0.40	0.42	0.46	0.50	0.54	0.58	0.62	0.66	0.70	0.74	0.78	0.82	0.96	1.09	1.26	1.39	1.52	1.65
WINTER STORAGE (MG)												218	234	250	267	283	299	315	332	387	441	501	561	614	669
LAND AREA (ACRE)												382	411	439	469	498	526	554	584	680	775	880	986	1080	1176

PLAN C PLANT 16

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	0	0	0	94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	94	0	0	188	47	93	5	87	83	2	81	73	0	72
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	3872	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3872	387	3310	31	3279	3159	15	3144	2907	3	2904
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	336	0	0	0	0	0	0	0	0	0	0	0	720	0	0	0	0	1056	499	387	40	346	303	19	284	206	4	201
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	30	0	0	0	0	580	0	0	0	0	0	0	0	0	0	0	0	0	0	0	650	0	0	0	580	0	2450	1114	1104	90	1014	947	43	903	765	12	752
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	160	0	0	0	0	0	0	0	160	0	0	0	0	160	0	480	160	173	12	160	137	6	131	93	1	91
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	144	0	0	0	0	0	0	0	0	0	0	0	0	0	0	144	35	85	2	82	73	1	71	55	0	55
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	1170	0	0	0	0	0	0	0	470	0	485	0	440	0	0	2585	399	1050	32	1018	841	15	825	582	3	578
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	287	0	0	0	0	0	0	0	387	0	488	0	573	0	573	2318	573	564	46	517	404	22	382	239	5	233
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	312	0	0	0	76	0	0	0	64	63	70	77	62	64	0	0	788	310	63	246	247	30	216	169	7	162
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	192	0	0	0	28	0	0	0	61	23	25	25	22	175	28	541	226	168	18	150	130	8	121	86	2	84
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	210	0	0	0	52	0	0	0	43	43	47	48	42	43	0	528	173	208	14	194	166	6	159	114	1	112
SLUDGE MANAGEMENT	35	0	0	0	0	161	0	0	0	0	0	0	0	0	0	0	0	0	0	0	85	0	0	0	161	0	407	158	172	12	160	149	6	143	122	1	120
MISCELLANEOUS	33	0	0	0	0	98	0	0	0	0	0	46	0	0	0	10	0	0	0	11	77	9	10	8	114	1	384	0	155	0	155	130	0	130	101	0	101
TOTAL		0	0	0	3966	1239	0	0	0	330	0	2491	0	0	0	166	0	0	0	1158	581	1844	180	1261	1657	602	15153	4575	7786	370	7415	6774	178	6596	5515	45	5469
PW (1/72) 5 3/8%		0	0	0	3390	1004	0	0	0	221	0	1474	0	0	0	79	0	0	0	467	294	425	28	172	178	48	0	0	7786	370	7415	0	0	0	0	0	0
PW (1/72) 7%		0	0	0	3236	949	0	0	0	195	0	1249	0	0	0	64	0	0	0	354	204	276	17	55	43	23	0	0	0	0	0	6774	178	6596	0	0	0
PW (1/72) 10%		0	0	0	2978	846	0	0	0	156	0	961	0	0	0	43	0	0	0	219	105	127	6	34	28	6	0	0	0	0	0	0	0	0	5515	45	5469

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	123	145	163	184	207	3	3	3	4	4	4	4	4	4	4	4	4	8	8	9	11	12	14	15	17	1237	0	784	0	784	723	0	723	640	0	640
SLUDGE FACILITIES	35	6	7	8	9	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40	0	33	0	33	32	0	32	29	0	29
SEWERS	50	0	0	0	19	19	19	19	19	21	21	21	21	21	21	21	21	21	21	21	22	24	24	24	24	24	1005	0	305	0	305	233	0	233	152	0	152
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	30	0	0	0	0	0	58	60	62	64	66	67	68	70	72	74	76	78	80	83	87	91	94	96	99	102	3685	0	998	0	998	732	0	732	445	0	445
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	22	22	24	25	25	27	28	41	43	46	49	52	56	59	2645	0	348	0	348	233	0	233	139	0	139
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	6	6	6	6	6	6	6	8	11	11	11	13	13	13	372	0	77	0	77	51	0	51	26	0	26
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	18	18	19	19	20	20	20	27	28	33	34	35	36	37	1109	0	240	0	240	161	0	161	83	0	83
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	12	13	13	14	14	15	15	19	21	24	27	30	30	30	871	0	182	0	182	122	0	122	62	0	62
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	4	4	4	5	5	6	6	6	7	7	204	0	43	0	43	29	0	29	14	0	14
SLUDGE MANAGEMENT	35	0	0	0	0	0	2	2	3	3	3	3	3	4	4	4	4	4	5	5	6	7	7	8	9	9	255	0	60	0	60	42	0	42	24	0	24
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		129	150	171	212	236	86	88	91	96	98	99	164	169	175	179	184	189	192	224	236	263	274	275	299	259	10460	0	3086	0	0	2967	0	0	1602	0	0
PW (BEGIN PER) 5 3/8%		122	142	162	201	221	81	83	86	91	92	95	155	160	166	170	174	179	182	984	1062	1144	1195	1255	1281	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%		122	135	146	171	190	62	60	59	59	58	57	87	85	85	82	80	78	76	384	316	265	213	171	134	0	0	0	3173	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%		120	140	155	196	218	80	82	85	89	91	92	155	157	163	167	172	176	179	944	1020	1098	1155	1218	1223	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%		120	130	139	161	166	57	56	52	52	48	47	72	70	67	66	62	59	56	274	215	164	123	92	67	0	0	0	0	0	0	2431	0	0	0	0	0
PW (BEGIN PER) 10%		117	136	155	192	212	78	80	82	87	89	89	149	151	155	162	167	171	174	988	944	1029	1078	1098	1153	0	311	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%		117	123	128	144	145	48	45	42	40	37	34	52	49	46	42	40	37	34	156	105	71	46	29	19	0	0	0	0	0	0	0	0	0	1639	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	0	0	0	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7											
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SEWERS	50	0	0	0	278	278	278	278	278	278	278	278	278	278	278	278	278	278	278	278	278	278	278	278	278	278											
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	24	24	24	24	24	24	24	24	24	24	24	76	76	76	76	76											
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
AERATED LAGOONS	30	0	0	0	0	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	125	125	125	125	125	125											
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	12	12	12	12	12	12	12	12	24	24	24	24	24	24	24											
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10											
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	84	84	84	84	84	84	84	84	118	118	153	153	186	186	186											
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	49	49	49	49	49	49	49	49	65	64	81	81	55	95	69											
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	22	22	22	22	27	27	27	27	32	37	42	47	52	56	56											
IRRIGATION SYSTEMS	33		0	0	0	0	0	0	0	0	0	11	11	11	11	14	14	14	14	18	20	22	24	26	28	28											
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	15	15	15	15	15	16	18	18	21	25	28	31	34	38	38											
SLUDGE MANAGEMENT	35	0	0	0	0	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	18	18	18	18	19	18											
MISCELLANEOUS	33	0	0	0	0	7	7	7	7	7	7	11	11	11	11	12	12	12	12	12	18	19	20	13	18	17											
5 3/8% CRF		0	0	0	250	307	307	307	307	327	327	503	503	503	503	513	513	513	513	574	636	731	741	782	795	796											
7% CRF		0	0	0	286	379	379	379	379	407	407	613	613	613	613	625	625	625	625	700	773	888	900	945	966	963											
10% CRF		0	0	0	400	527	527	527	527	561	561	839	839	839	839	856	856	856	856	955	1056	1211	1228	1254	1316	1313											

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

CAPITAL RECOVERY FACTOR AT 5 3/8%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	0	0	0	250	307	307	307	307	327	327	503	503	503	503	513	513	513	513	574	636	731	741	782	795	796
TOTAL ANNUAL O&M	129	150	171	212	236	86	88	91	96	98	99	164	169	175	179	184	189	192	224	236	263	274	275	299	259
TOTAL ANNUAL COSTS	129	150	171	462	543	393	395	398	423	425	[illegible]	667	672	678	692	697	702	705	800	872	994	1015	1071	1094	1093

CAPITAL RECOVERY FACTOR AT 7%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	0	0	0	286	379	379	379	379	403	403	613	613	613	613	625	625	625	625	700	773	888	900	945	966	963
TOTAL ANNUAL O&M	129	150	171	212	236	86	88	91	96	98	99	164	169	175	179	184	189	192	224	236	263	274	275	299	259
TOTAL ANNUAL COSTS	129	150	171	498	615	465	467	470	499	501	712	777	782	788	804	809	814	817	924	1009	1151	1174	1236	1263	1262

CAPITAL RECOVERY FACTOR AT 10%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	0	0	0	400	527	527	527	527	561	561	839	839	839	839	856	856	856	856	955	1056	1211	1228	1254	1316	1313
TOTAL ANNUAL O&M	129	150	171	212	236	86	88	91	96	98	99	164	169	175	179	184	189	192	224	236	263	274	275	299	259
TOTAL ANNUAL COSTS	129	150	171	612	763	613	615	618	657	659	938	1003	1008	1014	1035	1040	1045	1048	1179	1292	1474	1502	[illegible]	1613	1572

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

CHAGRIN EAST BRANCH PLANT   SIZE: 1.95 MGD   SOIL-Y PREPARING   APPLICATION RATE: 90 IN/YR   CHAGRIN EAST BRANCH PLANT

- - - - - BASIC DESIGN DATA - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
POPULATION																									
DOMESTIC AND INDUSTRIAL Q				0.60	0.62	0.65	0.67	0.69	0.72	0.75	0.77	0.80	0.83	0.87	0.89	0.92	0.95	0.98	1.00	1.12	1.25	1.41	1.58	1.76	1.95
TREATMENT PLANT CAPACITY (MGD)					1.12						1.00								1.25	1.41	1.58	1.76	1.95	1.95	1.95
SLUDGE DISCHARGED (TPD)							0.14	0.14	0.15	0.16	0.16	0.17	0.17	0.18	0.19	0.19	0.20	0.21	0.21	0.24	0.26	0.30	0.33	0.37	0.41
WINTER STORAGE (MG)												68	71	74	76	78	81	83	85	95	106	120	134	150	166
LAND AREA (ACRE)												119	124	130	133	137	142	146	149	167	187	210	236	263	291

PLAN C PLANT 17

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	819	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	542	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	19	0	0	0	0	370	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	15	0	0	0	0	0	0	0	0	0	0	120	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	54	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	420	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	88	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	20	0	0	0	0	0	0	0	0	0	89	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	71	0	0	0	11	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0
SLUDGE MANAGEMENT	39	0	0	0	0	83	0	0	0	0	0	60	0	0	0	7	0	0	0
MISCELLANEOUS	33	0	0	0	0	37	0	0	0	0	0	14	0	0	0	1	0	0	0
TOTAL		20	0	0	859	490	0	0	0	542	0	916	0	0	0	23	0	0	0
PW (1/72) 5 3/8%		20	0	0	734	397	0	0	0	356	0	542	0	0	0	11	0	0	0
PW (1/72) 7 %		20	0	0	700	373	0	0	0	315	0	465	0	0	0	8	0	0	0
PW (1/72) 10 %		20	0	0	645	334	0	0	0	253	0	353	0	0	0	6	0	0	0

ITEM	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	0	0	0	0	40	0	0	80	28	39	2	37	35	1	34	31	0	30
EXPAND TO LEVEL 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	0	0	0	0	0	0	0	819	81	700	6	693	668	3	665	615	0	614
SEWER EXPANSION	0	0	0	0	0	0	0	542	108	356	8	347	315	4	311	253	1	252
DETENTION BASINS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	310	0	0	0	370	0	1050	440	432	35	396	368	17	350	293	4	289
SECONDARY PUMPING	120	0	0	0	0	120	0	360	120	130	9	120	103	4	98	69	1	68
FORCE MAINS	0	0	0	0	0	0	0	54	13	31	1	30	27	0	26	20	0	20
STORAGE RESERVOIRS	150	0	255	0	200	0	0	1025	474	393	38	355	311	18	292	212	4	207
RESERVOIR AER & CL	108	0	135	0	162	0	162	655	162	160	13	147	115	6	109	68	1	67
LAND PURCHASE & PREP	12	13	15	17	18	19	0	0	194	97	15	81	82	7	74	63	1	61
IRRIGATION SYSTEMS	4	5	5	6	7	78	4	184	82	58	6	52	46	3	43	31	1	31
DRAINAGE SYSTEMS	6	9	10	12	12	13	0	131	43	52	3	48	41	1	40	29	0	28
SLUDGE MANAGEMENT	0	32	0	0	0	83	0	198	79	85	6	79	74	3	71	61	0	60
MISCELLANEOUS	1	32	2	2	2	43	0	134	0	54	0	54	45	0	45	35	0	35
TOTAL	403	401	422	37	441	726	166	5232	1824	2593	147	2445	2235	71	2164	1786	18	1768
PW (1/72) 5 3/8%	157	120	97	6	60	76	13	0	0	2593	147	2445	0	0	0	0	0	0
PW (1/72) 7 %	119	84	63	3	33	39	6	0	0	0	0	0	2235	71	2164	0	0	0
PW (1/72) 10 %	72	44	29	1	11	12	1	0	0	0	0	0	0	0	0	1786	18	1768

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	71	76	62	67	62	2	2	2	3	3	3	3	3	3	3	3	3	3
SLUDGE FACILITIES	35	5	5	6	6	6	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	6	6	6	6	6	6	6	6	6	6	6	6	6	6
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	19	0	0	0	0	0	18	19	18	19	19	19	20	20	20	20	21	21	22
SECONDARY PUMPING	15	0	0	0	0	0	0	0	0	0	0	0	10	10	10	10	11	11	11
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	5	5	5	5	5	5	5
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0		0	0	0	0	5	5	5	5	5	5	5
DRAINAGE SYSTEMS	50	0	0	0	0	0			0	0	0	0	1	1	1	1	1	1	1
SLUDGE MANAGEMENT	39	0	0	0	0	0			1	1	1	1	1	1	1	1	1	1	1
MISCELLANEOUS	33	0	0	0	0	0			0	0	0	0	0	0	0	0	0	0	0
TOTAL		76	81	68	67	102	[illegible]	[illegible]	26	30	30	30	55	55	55	55	57	57	58
PW (BEGIN PER) 5 3/8%		72	76	83	92	96	[illegible]	[illegible]	24	28	28	28	52	52	52	52	54	54	55
PW (1/72) 5 3/8%		72	72	75	78	71	[illegible]	[illegible]	17	18	17	16	29	27	26	25	24	23	22
PW (BEGIN PER) 7%		71	75	82	90	91	24	24	24	28	28	28	51	51	51	51	53	53	54
PW (1/72) 7%		71	73	71	74	72	17	16	15	16	15	14	24	22	21	19	19	18	17
PW (BEGIN PER) 10%		69	73	90	88	82	23	23	23	27	27	27	50	50	49	49	51	51	52
PW (1/72) 10%		69	66	66	66	63	14	13	12	12	11	10	17	15	14	13	12	11	10

ITEM	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	4	4	5	5	6	7	8	595	0	393	0	393	366	0	366	324	0	324
SLUDGE FACILITIES	0	0	0	0	0	0	0	28	0	23	0	23	22	0	22	21	0	21
SEWERS	6	6	6	6	6	6	6	260	0	79	0	79	59	0	59	38	0	38
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	22	24	34	36	38	40	42	1275	0	316	0	316	227	0	227	136	0	136
SECONDARY PUMPING	18	18	19	20	21	22	23	663	0	142	0	142	96	0	96	49	0	49
FORCE MAINS	1	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
STORAGE RESERVOIRS	3	3	4	4	4	4	4	124	0	26	0	26	17	0	17	9	0	9
RESERVOIR AER & CL	6	6	8	8	10	10	11	285	0	60	0	60	40	0	40	20	0	20
LAND PURCHASE & PREP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	6	6	7	7	8	8	8	265	0	54	0	54	36	0	36	19	0	19
DRAINAGE SYSTEMS	1	1	2	2	2	2	2	57	0	11	0	11	7	0	7	4	0	4
SLUDGE MANAGEMENT	1	2	2	2	2	2	3	68	0	16	0	16	12	0	12	7	0	7
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	69	72	90	93	100	104	0	3641	0	1134	0	0	892	0	0	632	0	0
PW (BEGIN PER) 5 3/8%	299	346	390	409	435	454	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%	116	104	90	72	59	47	0	0	0	1155	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%	287	332	373	394	422	433	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%	85	70	55	42	32	23	0	0	0	0	0	0	0	0	0	0	0	0
PW (BEGIN PER) 10%	264	307	349	368	377	405	2	63	0	0	0	0	907	0	0	0	0	0
PW (1/72) 10%	47	34	24	15	10	6	0	0	0	0	0	0	0	0	0	640	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	19	0	0	0	0	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	51	51	51	51	51	51
SECONDARY PUMPING	15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	18	18	18	18	18	18	18
FORCE MAINS	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3	3	3	3	3	3	3
STORAGE RESERVOIRS	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	30	30	30	30	30	30	30	30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
RESERVOIR AER & CL	10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
LAND PURCHASE & PREP	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
IRRIGATION SYSTEMS	33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DRAINAGE SYSTEMS	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SLUDGE MANAGEMENT	39	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MISCELLANEOUS	33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5 3/8% CRF		1	1	1	51	81	81	81	81	113	113	176	176	176	176	177	177	177	177	198	223	244	246	262	266	266
7 % CRF		1	1	1	63	100	100	100	100	139	139	216	216	216	216	216	216	216	216	241	272	297	299	318	323	323
10 % CRF		2	2	2	89	139	138	138	138	193	193	296	296	296	296	296	296	296	296	332	371	405	409	434	441	441

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

CAPITAL RECOVERY FACTOR AT 5 3/8%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	1	1	1	51	81	81	81	81	113	113	176	176	176	176	177	177	177	177	198	223	244	246	262	266	266
TOTAL ANNUAL O&M	76	81	68	67	102	26	26	26	30	30	30	55	55	55	55	57	57	58	69	72	90	93	100	104	108
TOTAL ANNUAL COST	77	82	69	118	183	107	107	107	143	143	206	231	231	231	232	234	234	235	267	295	334	339	362	370	374

CAPITAL RECOVERY FACTOR AT 7 %

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	1	1	1	63	100	100	100	100	139	139	216	216	216	216	216	216	216	216	241	272	297	299	318	323	323
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL COST	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	126	169	169	246	271	271	271	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CAPITAL RECOVERY FACTOR AT 10 %

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	2	2	2	89	139	138	138	138	193	193	296	296	296	296	296	296	296	296	332	371	405	409	434	441	441
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL COST	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	164	223	223	326	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

UPPER EAST BRANCH PLANT   SCCE2   (LLL-MGD)   SOIL-7 TYPE: RANCHING   APPLICATION RATE: 50 IN/YR   UPPER EAST BRANCH PLANT

- - - - - BASIC DESIGN DATA - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
POPULATION																									
DOMESTIC AND INDUSTRIAL Q				0.22	0.24	0.27	0.30	0.33	0.36	0.39	0.42	0.45	0.49	0.52	0.55	0.58	0.61	0.65	0.68	0.74	0.81	0.89	0.96	1.03	1.11
TREATMENT PLANT CAPACITY (MGD)					0.76						0.68								0.81	0.85	0.96	1.03	1.11	1.22	1.22
SLUDGE DISCHARGED (TPD)						0.06	0.06	0.07	0.08	0.08	0.09	0.09	0.10	0.11	0.12	0.12	0.13	0.14	0.14	0.16	0.17	0.19	0.20	0.21	0.23
WINTER STORAGE (MG)												38	42	44	47	49	52	55	58	63	69	76	82	88	94
LAND AREA (ACRE)												67	73	78	82	87	91	92	102	110	121	133	143	154	166

PLAN C PLANT 18

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	0	0	0	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	0	0	52	18	25	1	24	23	0	22	20	0	20
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	280	0	0	0	0	0	0	0	0	0	0	0	0	0	0	250	0	0	0	280	0	710	200	301	16	285	260	7	252	212	2	210
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	97	0	0	0	0	0	0	0	86	0	0	0	0	97	0	280	95	101	7	93	80	3	76	54	0	53
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	90	22	53	1	51	45	0	44	34	0	34
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	360	0	0	0	0	0	0	0	110	0	120	0	120	0	0	710	114	300	9	290	242	4	238	170	1	169
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	78	0	0	0	0	0	0	0	93	0	110	0	126	0	126	533	126	135	10	125	98	4	93	59	1	57
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	55	0	0	0	7	0	0	0	5	7	5	4	4	4	0	0	91	42	7	35	35	3	31	25	0	24
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	44	0	0	0	5	0	0	0	2	3	2	2	2	48	5	115	50	37	4	33	30	1	28	20	0	20
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	37	0	0	0	9	0	0	0	4	4	5	5	5	5	0	76	18	32	1	30	26	0	25	18	0	18
SLUDGE MANAGEMENT	39	0	0	0	0	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	82	0	182	74	80	5	74	70	2	67	59	0	58
MISCELLANEOUS	33	0	0	0	0	28	0	0	0	0	0	9	0	0	0	1	0	0	0	0	15	0	0	0	32	0	84	0	36	0	36	31	0	31	25	0	25
TOTAL		0	0	0	26	390	0	0	0	0	0	772	0	0	0	22	0	0	0	300	157	242	11	283	567	131	2830	808	1146	65	1081	944	31	912	701	8	693
PW (1/72) 5 3/8%		0	0	0	22	316	0	0	0	0	0	457	0	0	0	10	0	0	0	117	55	55	1	38	57	10	0	0	1146	65	1081	0	0	0	0	0	0
PW (1/72) 7%		0	0	0	21	257	0	0	0	0	0	392	0	0	0	8	0	0	0	88	41	34	1	21	30	5	0	0	0	0	0	944	31	912	0	0	0
PW (1/72) 10%		0	0	0	19	264	0	0	0	0	0	297	0	0	0	5	0	0	0	54	22	16	0	7	9	1	0	0	0	0	0	0	0	0	701	8	693

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	0	0	0	1	1	1	1	1	2	2	2	2	2	3	3	3	3	3	4	4	5	6	7	7	8	195	0	44	0	44	31	0	31	17	0	17
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	0	11	11	11	12	12	12	13	13	14	14	15	15	15	16	22	22	23	24	24	25	838	0	213	0	213	155	0	155	90	0	90
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	7	7	7	8	8	8	8	8	11	11	11	12	12	12	12	309	0	89	0	89	61	0	61	32	0	32
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	1	2	2	2	2	2	2	2	2	2	2	3	3	3	3	89	0	19	0	19	13	0	13	7	0	7
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	3	4	4	4	5	5	6	6	6	172	0	36	0	36	24	0	24	12	0	12
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	3	3	4	4	4	4	5	5	5	151	0	33	0	33	22	0	22	12	0	12
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
SLUDGE MANAGEMENT	39	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	43	0	12	0	12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		0	0	0	1	1	14	14	14	16	16	16	34	34	37	37	38	38	39	45	51	53	57	61	61	63	1966	0	468	0	0	328	0	0	185	0	0
PW (BEGIN PER) 5 3/8%		0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	205	222	235	251	260	265	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%		0	0	0	0	0	10	9	9	9	9	8	18	17	17	16	16	15	15	80	66	56	44	35	27	0	0	0	468	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%		0	0	0	0	0	13	13	13	14	14	14	31	31	34	34	35	35	36	197	213	225	242	252	253	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%		0	0	0	0	0	9	8	8	8	8	7	15	14	14	13	12	12	11	58	44	33	25	19	13	0	0	0	0	0	0	341	0	0	0	0	0
PW (BEGIN PER) 10%		0	0	0	0	0	12	12	12	14	14	14	30	30	33	33	34	34	35	181	197	211	226	225	237	1	[illegible]	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%		0	0	0	0	0	7	7	6	6	6	5	10	9	9	8	8	7	7	32	22	14	9	6	4	0	0	0	0	0	0	0	0	0	192	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2											
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
AERATED LAGOONS	39	0	0	0	0	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	32	32	32	32	32	32											
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	7	7	7	7	7	7	7	7	14	14	14	14	14	14	14											
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6											
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	25	25	25	25	25	25	25	25	33	33	42	42	51	51	51											
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	13	13	13	13	13	13	13	13	15	15	18	18	21	21	21											
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	3	3	3	3	4	4	4	4	4	5	5	5	6	6	6											
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4											
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	2	2	2	2	3	3	3	3	3	3	4	4	4	5	5											
SLUDGE MANAGEMENT	39	0	0	0	0	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	7	7	7	7	7	7											
MISCELLANEOUS	33	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	4	4	4	1	3	3											
5 3/8% CRF		0	0	0	1	25	25	25	25	25	25	79	79	79	79	80	80	80	80	95	108	118	119	127	129	129											
7% CRF		0	0	0	2	31	31	31	31	31	31	95	95	95	95	96	96	96	96	124	129	141	142	152	155	155											
10% CRF		0	0	0	2	42	42	42	42	42	42	127	127	127	127	129	129	129	129	153	174	190	191	204	208	208											

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
CAPITAL RECOVERY FACTOR AT 5 3/8%																									
TOTAL ANNUAL CAPITAL	0	0	0	1	25	25	25	25	25	25	79	79	79	79	80	80	80	80	95	108	118	119	127	129	129
TOTAL ANNUAL O&M	0	0	0	1	1	14	14	14	16	16	16	34	34	37	37	38	38	39	45	51	53	57	61	61	63
TOTAL ANNUAL COSTS	0	0	0	2	25	39	39	39	41	41	95	113	113	116	117	118	118	119	140	159	171	176	188	190	192
CAPITAL RECOVERY FACTOR AT 7%																									
TOTAL ANNUAL CAPITAL	0	0	0	2	31	31	31	31	31	31	95	95	95	95	96	96	96	96	124	129	141	142	152	155	155
TOTAL ANNUAL O&M	0	0	0	1	1	14	14	14	16	16	16	34	34	37	37	38	38	39	45	51	53	57	61	61	63
TOTAL ANNUAL COSTS	0	0	0	3	32	45	45	45	47	47	111	129	129	132	133	134	134	135	169	180	194	199	213	216	218
CAPITAL RECOVERY FACTOR AT 10%																									
TOTAL ANNUAL CAPITAL	0	0	0	2	42	42	42	42	42	42	127	127	127	127	129	129	129	129	153	174	190	191	204	208	208
TOTAL ANNUAL O&M	0	0	0	1	1	14	14	14	16	16	16	34	34	37	37	38	38	39	45	51	53	57	61	61	63
TOTAL ANNUAL COSTS	0	0	0	3	43	56	56	56	58	58	143	161	161	164	166	167	167	168	198	225	243	248	265	269	271

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

HINCKLEY PLANT SIZE: 1.72(MGD) SOIL-T PRETREATING APPLICATION RATE: 90 IN/YR HINCKLEY PLANT

- - - - - BASIC DESIGN DATA - - - - -

1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	
																									POPULATION
			3.33	0.37	0.42	0.46	0.51	0.55	0.60	0.64	0.69	0.74	0.79	0.84	0.89	0.94	0.99	1.06	1.15	1.25	1.37	1.50	1.61	1.72	DOMESTIC AND INDUSTRIAL Q
				1.15						1.04								1.25	1.37	1.5C	1.61	1.72	1.72	1.72	TREATMENT PLANT CAPACITY (MGD)
					0.09	0.10	0.11	0.12	0.13	0.13	0.15	0.16	0.17	0.18	C.19	0.20	0.21	0.22	0.24	0.26	0.25	C.32	0.34	0.36	SLUDGE DISCHARGED (TPD)
											59	63	67	71	76	80	84	88	98	106	116	127	137	146	WINTER STORAGE (MG)
											103	111	118	125	133	140	148	155	17C	187	205	224	240	255	LAND AREA (ACRE)

PLAN C PLANT 19

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	0	0	0	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36	0	0	72	25	35	2	33	32	0	31	28	0	27
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	C	0	C	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	40	0	0	C	2030	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2030	283	2419	22	2396	2309	11	2298	2125	3	2122
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	6	0	0	0	0	0	0	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	15	0	0	0	0	375	0	0	0	0	0	0	0	0	0	0	0	0	0	0	330	0	0	0	275	0	980	415	412	33	378	355	16	339	288	4	284
SECONDARY PUMPING	17	0	0	0	0	0	0	0	0	0	0	117	0	0	0	0	0	0	0	104	0	0	0	0	117	0	338	115	122	9	112	96	4	92	65	1	64
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	143	0	0	0	0	0	0	0	0	0	0	0	0	0	0	143	34	84	2	81	72	1	71	55	0	54
STORAGE RESERVOIRS	50	0	0	0	0	0	C	0	0	0	0	440	0	0	0	0	0	0	0	122	C	150	0	132	0	0	854	353	364	28	336	295	13	281	207	[illegible]	203
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	92	0	0	0	0	0	0	0	108	0	129	0	145	0	145	619	145	157	11	146	114	5	109	69	[illegible]	67
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	89	0	0	0	21	0	0	0	11	11	14	13	12	12	0	0	182	78	14	63	63	7	56	45	[illegible]	43
IRRIGATION SYSTEMS	15	0	0	0	0	0	0	0	0	0	0	62	0	0	0	11	0	0	0	10	5	15	15	10	72	13	219	58	65	7	57	50	4	46	35	[illegible]	32
DRAINAGE SYSTEMS	40	0	0	0	0	0	0	0	0	0	0	55	0	0	0	13	0	0	0	7	7	8	8	7	7	0	112	24	48	1	46	39	1	38	27	0	27
SLUDGE MANAGEMENT	15	0	0	0	0	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0	0	0	82	0	191	77	83	6	76	72	3	69	62	0	59
MISCELLANEOUS	15	0	0	0	0	37	0	0	0	0	0	13	0	0	0	3	0	0	0	1	24	2	2	1	42	0	125	0	52	0	52	44	0	44	34	0	34
TOTAL		0	0	0	2866	494	0	0	0	0	0	1011	0	0	0	50	0	0	0	373	308	318	38	343	706	158	6493	1751	1925	141	1783	3546	68	3478	3041	17	3023
PW (1/72) 5 3/8%		0	0	0	2450	400	0	0	0	0	0	598	0	0	0	24	0	0	0	145	92	73	6	46	74	12	0	0	1925	141	1783	0	0	0	0	0	0
PW (1/72) 7 %		0	0	0	2338	376	0	0	0	0	0	513	0	0	0	19	0	0	0	110	64	47	4	24	38	6	0	0	0	0	0	3546	68	3478	0	0	0
PW (1/72) 10 %		0	0	0	2152	337	0	0	0	0	0	390	0	0	0	13	0	0	0	67	34	21	1	9	12	1	C	0	C	0	0	0	0	0	3041	17	3023

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

	ITEM LIFE	1972–1990, 1995–2020, TOTAL EXPEND, TOTAL RESID, PRESENT WORTH AT 5 3/8% EXPEND / RESID / NET, PRESENT WORTH AT 7% EXPEND / RESID / NET, PRESENT WORTH AT 10% EXPEND / RESID / NET
PLANTS	35	[illegible]
SLUDGE FACILITIES	35	[illegible]
SEWERS	40	[illegible]
TEMPORARY PUMPS	6	[illegible]
SHAFTS & TUNNELS	50	[illegible]
AERATED LAGOONS	15	[illegible]
SECONDARY PUMPING	17	[illegible]
FORCE MAINS	50	[illegible]
STORAGE RESERVOIRS	50	[illegible]
RESERVOIR AER & CL	10	[illegible]
LAND PURCHASE & PREP	50	[illegible]
IRRIGATION SYSTEMS	15	[illegible]
DRAINAGE SYSTEMS	40	[illegible]
SLUDGE MANAGEMENT	15	[illegible]
MISCELLANEOUS	15	[illegible]
TOTAL		[illegible]
PW (BEGIN PER) 5 3/8		[illegible]
PW (1/72) 5 3/8		[illegible]
PW (BEGIN PER) 7%		[illegible]
PW (1/72) 7%		[illegible]
PW (BEGIN PER) 10%		[illegible]
PW (1/72) 10%		[illegible]

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
EXPAND TO LEVEL 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	C	0	0	C	0	0	0
EXPAND TO LEVEL 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	C	0	0	0	0	0	0
SLUDGE FACILITIES	0	0	0	0	0	0	0	0	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	0	0	0	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203	203
SEWER EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	0	0	0	0	0	0	C	0	0	0	0	0	0	0	0	0	0	0	C	0	0	0	0	0	0
BASIN EXPANSION	0	0	0	0	0	0	C	0	0	0	0	0	0	0	0	0	0	0	C	C	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	0	0	0	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	45	45	45	45	45	45
SECONDARY PUMPING	0	0	0	0	0	0	0	0	0	0	9	9	9	9	9	9	9	9	17	17	17	17	17	17	17
FORCE MAINS	0	0	0	0	0	0	0	0	0	0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
STORAGE RESERVOIRS	0	0	0	0	0	0	0	0	0	0	31	31	31	31	31	31	31	31	41	41	51	51	61	61	61
RESERVOIR AER & CL	0	0	0	0	0	0	0	0	0	0	15	15	15	15	15	15	15	15	18	18	21	21	24	24	24
LAND PURCHASE & PREP	0	0	0	0	0	0	0	0	0	0	6	6	6	6	7	7	7	7	8	9	10	11	12	13	13
IRRIGATION SYSTEMS	0	0	0	0	0	0	0	0	0	0	4	4	4	4	5	5	5	5	6	7	8	9	10	11	11
DRAINAGE SYSTEMS	0	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5	5	6	7	7	9	9
SLUDGE MANAGEMENT	0	0	0	0	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	9	9	8	8	9	8
MISCELLANEOUS	0	0	0	0	2	2	2	2	2	2	3	3	3	3	4	4	4	4	4	2	6	6	1	5	5
5 3/8 PCT	0	0	0	176	197	197	197	197	197	197	266	266	266	266	269	269	269	269	287	337	321	323	333	338	338
7 PCT	0	0	0	204	243	243	243	243	243	243	326	326	326	326	[illegible]	[illegible]	330	330	352	[illegible]	332	395	407	411	411
10 PCT	0	0	0	284	340	340	340	340	340	340	450	450	450	450	455	455	455	455	495	517	540	544	[illegible]	565	565

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

CAPITAL RECOVERY FACTOR AT 5 3/8%

	1972–2020
TOTAL ANNUAL CAPITAL	[illegible]
TOTAL ANNUAL O&M	[illegible]
TOTAL ANNUAL	[illegible]

CAPITAL RECOVERY FACTOR AT 7%

	1972–2020
TOTAL ANNUAL CAPITAL	[illegible]
TOTAL ANNUAL O&M	[illegible]
TOTAL ANNUAL	[illegible]

CAPITAL RECOVERY FACTOR AT 10%

	1972–2020
TOTAL ANNUAL CAPITAL	[illegible]
TOTAL ANNUAL O&M	[illegible]
TOTAL ANNUAL	[illegible]

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

MEDINA COUNTY PLANT   SIZE: 5.00(MGD)   SOIL-T YPE:MAHONING   APPLICATION RATE 90 IN/YR   MEDINA COUNTY PLANT

- - - - - BASIC DESIGN DATA - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
POPULATION																									
DOMESTIC AND INDUSTRIAL				0.86	0.95	1.04	1.13	1.22	1.31	1.37	1.44	1.50	1.57	1.63	1.70	1.76	1.83	1.89	1.96	2.26	2.57	2.99	3.41	4.20	5.00
TREATMENT PLANT CAPACITY (MGD)						2.28					1.96								2.57	2.55	3.41	4.21	5.00	5.00	5.00
SLUDGE DISCHARGE (TPD)						0.22	0.24	0.25	0.28	0.29	0.30	0.32	0.33	0.34	0.36	0.37	0.38	0.40	0.41	0.48	0.55	0.63	0.72	0.88	1.05
WINTER STORAGE (MG)												127	133	138	144	150	156	161	167	192	218	254	290	357	425
LAND AREA (ACRES)												224	235	244	254	263	274	282	293	332	383	447	510	628	747

PLAN C PLANT 20   PLAN C PLANT 23

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	0	0	0	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	70	0	0	140	49	69	3	65	62	1	60	56	0	53
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	1336	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1336	133	1142	10	1131	1090	5	1084	1003	1	1002
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	580	0	0	0	0	0	0	0	0	0	0	0	0	0	0	670	0	0	0	580	0	1830	757	732	61	670	615	29	586	481	7	473
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	138	0	0	0	0	0	0	0	138	0	0	0	0	138	0	414	128	150	10	139	118	4	113	80	1	79
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	240	58	142	4	137	121	2	119	92	0	92
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	700	0	0	0	0	0	0	0	300	0	370	0	280	0	0	1650	243	655	19	635	521	9	511	357	2	354
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	160	0	0	0	0	0	0	0	210	0	275	0	390	0	390	1425	390	325	31	293	229	15	214	132	3	129
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	169	0	0	0	26	0	0	0	30	30	43	42	78	79	0	[illegible]	497	169	40	129	132	19	112	89	4	84
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	97	0	0	0	16	0	0	0	65	12	17	17	31	120	10	367	163	108	13	95	83	6	76	54	1	52
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	114	0	0	0	18	0	0	0	21	20	28	28	53	54	0	336	144	114	11	102	89	5	83	60	1	58
SLUDGE MANAGEMENT	39	0	0	0	0	105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	69	0	0	0	105	0	279	106	116	8	108	100	4	96	81	1	80
MISCELLANEOUS	33	0	0	0	0	58	0	0	0	0	0	25	0	0	0	3	0	0	0	6	71	6	6	11	74	0	260	0	98	0	98	81	0	81	61	0	61
TOTAL		0	0	0	1406	743	0	0	0	0	0	1643	0	0	0	57	0	0	0	750	872	739	93	913	1150	400	8277	2670	3825	216	3608	3246	104	3142	2548	26	2521
PW (1/72) 5 3/8%		0	0	0	1202	452	0	0	0	0	0	972	0	0	0	27	0	0	0	292	261	170	16	125	121	32	0	0	3825	216	3608	0	0	0	0	0	0
PW (1/72) 7 %		0	0	0	1147	564	0	0	0	0	0	834	0	0	0	22	0	0	0	222	183	110	9	69	63	15	0	0	0	0	0	3246	104	3142	0	0	0
PW (1/72) 10 %		0	0	0	1055	507	0	0	0	0	0	634	0	0	0	16	0	0	0	135	57	50	3	24	19	4	0	0	0	0	0	0	0	0	2548	26	2521

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	46	33	18	2	2	2	2	2	3	3	3	3	3	4	4	4	4	4	5	6	7	8	9	11	13	384	0	155	0	155	133	0	133	110	0	110
SLUDGE FACILITIES	35	5	7	8	10	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	41	0	34	0	34	32	0	32	29	0	29
SEWERS	50	0	0	0	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	270	0	86	0	86	66	0	66	44	0	44
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	0	29	30	31	32	33	34	35	36	37	38	39	39	39	40	63	66	68	76	84	93	2562	0	615	0	615	437	0	437	253	0	253
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	15	15	15	16	16	16	17	18	19	28	30	33	36	41	975	0	199	0	199	152	0	132	67	0	67
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	4	4	4	4	4	4	4	5	5	7	7	8	8	8	233	0	49	0	49	33	0	33	17	0	17
RESERVOIR AER & CL	13	0	0	0	0	0	0	0	0	0	0	0	9	9	9	10	10	10	10	12	13	16	17	23	24	26	617	0	124	0	124	82	0	82	41	0	41
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	7	7	7	7	8	8	8	11	13	14	15	17	20	20	517	0	105	0	105	70	0	70	35	0	35
DRAINAGE SYSTEMS	50	0	0	0	0	0	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	4	4	5	104	0	21	0	21	14	0	14	7	0	7
SLUDGE MANAGEMENT	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	4	4	5	6	136	0	33	0	33	23	0	23	13	0	13
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		53	43	26	18	19	40	42	43	45	46	47	87	88	90	93	95	95	97	106	134	157	165	187	205	0	5876	0	1435	0	0	1034	0	0	625	0	0
PW (BEGIN PER) 5 3/8		50	41	24	17	19	37	39	40	42	43	44	82	83	85	88	90	90	92	513	621	690	751	836	508	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8		50	36	22	14	14	29	29	28	28	27	26	46	44	43	42	41	39	37	200	166	155	123	114	95	0	0	0	1490	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%		49	37	24	16	17	37	39	40	42	42	43	81	82	84	86	88	88	90	492	594	660	723	812	667	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%		49	34	21	13	13	26	26	25	24	23	22	38	36	34	33	32	30	28	145	125	99	77	61	47	0	0	0	0	0	0	1072	0	0	0	0	0
PW (BEGIN PER) 10%		48	36	23	16	17	36	38	39	40	41	42	79	80	81	84	86	86	88	453	550	618	675	725	810	6	188	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%		48	33	19	12	11	22	21	20	19	17	16	27	25	23	22	20	18	17	81	61	42	29	19	13	0	0	0	0	0	0	0	0	0	644	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	0	0	0	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5											
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SEWERS	50	0	0	0	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96											
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
AERATED LAGOONS	39	0	0	0	0	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	93	93	93	93	93	93											
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	10	10	10	10	10	10	10	10	21	21	21	21	21	21	21											
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17											
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	50	50	50	50	50	50	50	50	72	72	98	98	118	118	118											
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	26	25	25	26	26	26	26	26	35	37	45	45	65	65	65											
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	12	12	12	12	14	14	14	14	16	18	21	24	30	35	35											
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	7	7	7	7	9	9	9	9	11	12	15	16	20	20	20											
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	8	8	8	8	9	9	9	9	12	13	15	16	20	24	24											
SLUDGE MANAGEMENT	39	0	0	0	0	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	13	13	13	13	13	11											
MISCELLANEOUS	33	0	0	0	0	4	4	4	4	4	4	6	6	6	6	6	6	6	6	7	12	13	13	13	13	13											
5 3/8% CRF		0	0	0	81	128	128	128	128	128	128	241	241	241	241	244	244	244	244	265	335	376	381	422	435	435											
7 % CRF		0	0	0	101	157	157	157	157	157	157	292	292	292	292	296	296	296	296	345	410	454	461	509	525	526											
10 % CRF		0	0	0	142	218	218	218	218	218	218	398	398	398	398	404	404	404	404	468	557	617	627	687	709	709											

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
CAPITAL RECOVERY FACTOR AT 5 3/8%																									
TOTAL ANNUAL CAPITAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	128	128	128	128	128	241	241	241	241	244	244	244	244	[illegible]	[illegible]	376	381	[illegible]	435	435
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	40	42	43	45	46	47	87	88	[illegible]	93	95	95	97	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	168	170	171	173	176	288	328	329	331	337	339	339	341	361	471	533	546	609	640	654
CAPITAL RECOVERY FACTOR AT 7%																									
TOTAL ANNUAL CAPITAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	157	157	157	157	157	292	292	292	292	296	296	296	296	345	410	454	461	[illegible]	[illegible]	526
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	40	42	43	45	46	47	87	88	90	93	95	95	97	106	134	157	165	187	205	219
TOTAL ANNUAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	199	200	202	203	339	379	380	382	389	391	391	393	451	544	611	626	[illegible]	[illegible]	[illegible]
CAPITAL RECOVERY FACTOR AT 10%																									
TOTAL ANNUAL CAPITAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	218	218	218	218	218	398	398	398	398	404	404	404	404	468	557	617	627	[illegible]	[illegible]	709
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	42	43	45	46	47	87	88	90	93	95	95	97	106	134	157	165	187	205	219
TOTAL ANNUAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	260	261	263	264	445	485	486	488	497	499	499	501	574	691	774	792	[illegible]	[illegible]	[illegible]

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

NEW MEDINA PLANT SIZE: 9.49(MGD) SOIL-T YPE:RANCHING APPLICATION RATE: 90 IN/YR NEW MEDINA PLANT

- - - - - BASIC DESIGN DATA - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
POPULATION																									
DOMESTIC AND INDUSTRIAL Q	2.16	2.37	2.58	2.80	3.01	3.22	3.44	3.65	3.87	4.00	4.13	4.26	4.39	4.52	4.65	4.78	4.91	5.04	5.18	5.94	6.70	7.61	8.51	9.02	9.49
TREATMENT PLANT CAPACITY (MGD)					5.18														6.70		8.53		9.49	9.49	9.49
SLUDGE DISCHARGED (TPD)					0.63	0.68	0.72	0.77	0.81	0.84	0.87	0.89	0.92	0.95	0.98	1.00	1.03	1.06	1.09	1.29	1.41	1.60	1.75	1.85	1.99
WINTER STORAGE (MG)					256	274	292	310	329	340	351	362	373	384	395	406	417	428	440	505	570	647	725	767	807
LAND AREA (ACRES)					490	481	514	545	578	598	617	636	656	675	695	714	734	753	774	887	1001	1137	1274	1344	1418

PLAN C PLANT 21

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	0	0	0	105	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	1430	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	1070	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	312	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	500	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	1465	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	351	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	0	0	0	0	515	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	265	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	348	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	39	0	0	0	0	199	0	0	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	33	0	0	0	0	184	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		0	0	0	1535	5209	0	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%		0	0	0	1312	4224	0	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7 %		0	0	0	1252	3574	0	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10 %		0	0	0	1152	3557	0	0	0	0	0	0	0	0	0	0	0	0	0

ITEM	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	0	0	0	0	105	0	0	210	74	104	5	98	93	2	90	81	0	80
EXPAND TO LEVEL 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	0	0	0	0	0	0	0	1430	143	1222	11	1211	1166	5	1161	1073	1	1072
SEWER EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	940	0	0	0	0	1070	0	3080	1148	1346	92	1253	1153	44	1108	916	11	906
SECONDARY PUMPING	312	0	0	0	312	0	0	936	246	417	19	397	354	9	344	277	2	275
FORCE MAINS	0	0	0	0	0	0	0	500	70	405	5	399	381	2	378	341	0	340
STORAGE RESERVOIRS	560	0	645	0	385	0	0	3055	1124	1608	91	1517	1409	43	1365	1156	11	1145
RESERVOIR AER & CL	440	0	615	0	683	0	692	2821	692	763	56	707	581	26	554	393	6	387
LAND PURCHASE & PREP	151	0	182	0	96	0	0	[illegible]	945	531	76	455	472	36	435	354	4	350
IRRIGATION SYSTEMS	111	0	72	0	303	0	0	751	249	316	20	296	268	9	259	214	2	211
DRAINAGE SYSTEMS	102	0	123	0	65	0	0	638	216	359	17	341	319	8	310	266	2	264
SLUDGE MANAGEMENT	122	0	0	0	0	199	0	520	201	229	16	213	199	7	191	161	2	159
MISCELLANEOUS	118	0	26	0	27	107	0	467	0	216	0	216	187	0	187	151	0	151
TOTAL	2896	0	1663	0	1976	1376	692	14403	5108	7521	413	7108	6586	199	6387	5430	51	5379
PW (1/72) 5 3/8%	1129	0	384	0	270	144	56	0	0	7521	413	7108	0	0	0	0	0	0
PW (1/72) 7 %	857	0	249	0	150	75	26	0	0	0	0	0	6586	199	6387	0	0	0
PW (1/72) 10 %	521	0	114	0	53	23	6	0	0	0	0	0	0	0	0	5430	51	5379

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	161	176	192	208	223	6	6	6	8	8	8	8	9	9	9	9	9	9
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	0	68	70	72	74	76	78	80	81	83	90	97	104	111
SECONDARY PUMPING	33	0	0	0	0	0	27	28	30	31	32	33	34	36	38	40	42	43	45
FORCE MAINS	50	0	0	0	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3
STORAGE RESERVOIRS	50	0	0	0	0	0	7	7	7	7	7	7	7	7	7	7	7	7	7
RESERVOIR AER & CL	10	0	0	0	0	0	25	24	24	25	26	26	27	27	28	29	30	31	32
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	20	20	21	21	22	22	23	23	24	24	25	25	26
DRAINAGE SYSTEMS	50	0	0	0	0	0	5	5	5	5	5	5	5	5	5	5	5	5	5
SLUDGE MANAGEMENT	39	0	0	0	0	0	4	4	5	5	5	5	5	6	6	6	6	6	6
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		161	176	192	215	230	179	183	199	195	200	203	208	212	219	222	243	249	260
PW (BEGIN PER) 5 3/8		152	167	142	203	219	163	173	179	194	189	192	197	200	207	217	227	236	246
PW (1/72) 5 3/8%		152	154	166	174	177	130	126	124	121	119	116	111	137	105	106	101	102	101
PW (BEGIN PER) 7%		[illegible]	164	179	201	214	167	171	176	182	186	183	194	199	204	213	224	232	242
PW (1/72) 7%		[illegible]	153	156	164	163	115	114	107	106	101	96	92	87	84	82	81	78	76
PW (BEGIN PER) 10%		[illegible]	159	174	195	[illegible]	[illegible]	156	177	177	192	184	189	192	198	204	215	226	238
PW (1/72) 10%		[illegible]	145	144	144	142	100	93	88	82	77	71	66	51	57	54	52	49	46

ITEM	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	11	12	14	16	18	19	20	1528	0	952	0	952	875	0	875	772	0	772
SLUDGE FACILITIES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	7	7	7	7	7	7	7	315	0	100	0	100	77	0	77	51	0	51
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	118	132	135	146	156	161	167	5439	0	1372	0	1372	985	0	985	579	0	579
SECONDARY PUMPING	47	51	55	60	65	68	71	2239	0	565	0	565	406	0	406	239	0	239
FORCE MAINS	3	3	3	3	3	3	3	125	0	38	0	38	28	0	28	18	0	18
STORAGE RESERVOIRS	9	9	12	12	16	16	21	486	0	117	0	117	83	0	83	49	0	49
RESERVOIR AER & CL	32	37	41	45	48	49	50	1647	0	422	0	422	305	0	305	182	0	182
LAND PURCHASE & PREP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	27	30	33	35	38	38	38	1321	0	345	0	345	251	0	251	151	0	151
DRAINAGE SYSTEMS	6	6	8	8	9	9	9	330	0	77	0	77	56	0	56	34	0	34
SLUDGE MANAGEMENT	7	8	9	10	11	11	12	349	0	86	0	86	61	0	61	36	0	36
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	276	305	331	357	386	396	0	13753	0	4078	0	0	3192	0	0	2115	0	0
PW (BEGIN PER) 5 3/8	1250	1370	1474	1584	1669	1701	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%	487	421	340	291	229	174	0	0	0	4227	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%	1159	1311	1410	1525	1620	1624	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%	394	277	211	163	123	89	0	0	0	0	0	0	3240	0	0	0	0	0
PW (BEGIN PER) 10%	1103	1214	1321	1423	1448	1517	15	537	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%	158	136	91	61	39	25	0	0	0	0	0	0	0	0	0	2180	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	0	0	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SEWERS	50	0	0	0	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102
SEWER EXPANSION	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	[illegible]	0	0	0	0	80	80	80	80	80	80	80	80	80	80	80	80	80	80	150	150	150	150	150	150	150
SECONDARY PUMPING	[illegible]	0	0	0	0	24	24	24	24	24	24	24	24	24	24	24	24	24	24	48	48	48	48	48	48	48
FORCE MAINS	[illegible]	0	0	0	0	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
STORAGE RESERVOIRS	[illegible]	0	0	0	0	105	105	105	105	105	105	105	105	105	105	105	105	105	105	145	145	192	192	215	[illegible]	219
RESERVOIR AER & CL	[illegible]	0	0	0	0	40	40	40	40	40	40	40	40	40	40	40	40	40	40	56	56	126	126	147	147	156
LAND PURCHASE & PREP	[illegible]	0	0	0	0	37	37	37	37	37	37	37	37	37	37	37	37	37	37	47	47	61	61	67	67	67
IRRIGATION SYSTEMS	[illegible]	0	0	0	0	20	20	20	20	20	20	20	20	20	20	20	20	20	20	29	29	36	36	37	37	37
DRAINAGE SYSTEMS	[illegible]	0	0	0	0	25	25	25	25	25	25	25	25	25	25	25	25	25	25	32	32	42	42	45	45	45
SLUDGE MANAGEMENT	[illegible]	0	0	0	0	14	14	14	14	14	14	14	14	14	14	14	14	14	14	24	24	24	24	24	24	24
MISCELLANEOUS	[illegible]	0	0	0	0	14	14	14	14	14	14	14	14	14	14	14	14	14	14	23	23	24	24	25	21	21
5 3/8 PCT		0	0	0	89	417	417	417	417	417	417	417	417	417	417	417	417	417	417	574	576	724	754	749	692	763
7 % PCT		0	0	0	111	509	509	509	509	509	509	509	509	509	509	509	509	509	509	706	724	850	795	903	[illegible]	[illegible]
10 % PCT		0	0	0	155	697	697	697	697	697	697	697	697	697	697	697	697	697	697	961	961	1151	1096	1243	1149	1261

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

CAPITAL RECOVERY FACTOR AT 5 3/8%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL [illegible]	[illegible]	[illegible]	[illegible]	89	417	417	417	417	417	417	417	417	417	417	417	417	417	417	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	692	763
TOTAL ANN [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	200	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANN [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	417	627	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	677	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CAPITAL RECOVERY FACTOR AT 7 %

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANN [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	509	509	509	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	505	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANN [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	267	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANN [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	709	712	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	765	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CAPITAL RECOVERY FACTOR AT 10 %

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANN [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	697	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANN [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANN [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	953	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

MALLET CREEK PLANT — SCOPE PRELIMINARY — APPLICATION RATE — MALLET CREEK PLANT

- - - - - BASIC DESIGN DATA - - - - -

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
POPULATION / DOMESTIC AND INDUSTRIAL FLOW	3.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25	0.26	0.27	0.28	0.29	0.30	0.35	0.40	0.45	0.50	0.55	0.60
DESIGN PLANT CAPACITY (MGD)		0.35						0.30								0.40	0.45	0.50	0.55	0.60	0.60	[illegible]
SLUDGE (DS HAULED (TPD))			0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.08	0.09	0.11	0.12	0.13
WINTER STORAGE (MG)									26	27	28	29	30	32	33	34	40	45	51	56	62	68
LAND AREA (ACRES)									52	54	56	58	61	63	65	67	75	90	102	112	123	134

PLAN C PLANT 22

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
PLANTS	35	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPANC TO LEVEL 1	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPANC TO LEVEL 2	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	182	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	35	0	0	0	0	175	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	35	0	0	0	0	0	0	0	0	0	0	65	0	0	0	0	0	0	0	65
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	65	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	175	0	0	0	0	0	0	0	40
RESERVOIR AREA & CL	10	0	0	0	0	0	0	0	0	0	0	29	0	0	0	0	0	0	0	37
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	38	0	0	0	0	0	0	0	8
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	39	0	0	0	2	0	0	0	3
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	26	0	0	0	4	0	0	0	5
SLUDGE MANAGEMENT	15	0	0	0	0	41	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	33	0	0	0	0	17	0	0	0	0	0	6	0	0	0	0	0	0	0	1
TOTAL		0	0	0	202	233	0	0	0	0	0	442	0	0	0	6	0	0	0	159
PW (1/1/72) 5 3/8%		0	0	0	172	184	0	0	0	0	0	261	0	0	0	2	0	0	0	62
PW (1/1/72) 7%		0	0	0	169	177	0	0	0	0	0	224	0	0	0	2	0	0	0	47
PW (1/1/72) 10%		0	0	0	151	155	0	0	0	0	0	170	0	0	0	1	0	0	0	28

ITEM	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PW AT 5 3/8% EXPEND	PW AT 5 3/8% RESID	PW AT 5 3/8% NET	PW AT 7% EXPEND	PW AT 7% RESID	PW AT 7% NET	PW AT 10% EXPEND	PW AT 10% RESID	PW AT 10% NET
PLANTS	0	0	0	20	0	0	40	14	19	1	18	17	0	17	15	0	15
EXPANC TO LEVEL 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPANC TO LEVEL 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	0	0	0	0	0	0	182	19	155	1	154	148	[illegible]	147	136	0	136
SEWER EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	145	0	0	0	175	0	495	207	203	16	187	173	8	165	139	[illegible]	136
SECONDARY PUMPING	0	0	0	0	65	0	195	65	70	5	65	55	2	53	37	[illegible]	37
FORCE MAINS	0	0	0	0	0	0	65	16	38	1	37	33	0	32	25	0	26
STORAGE RESERVOIRS	0	40	0	40	0	0	295	52	133	4	129	109	2	107	78	0	78
RESERVOIR AREA & CL	0	47	0	55	0	55	223	55	54	4	45	59	2	56	23	0	22
LAND PURCHASE & PREP	7	7	7	7	7	0	[illegible]	81	32	6	25	25	3	22	17	0	17
IRRIGATION SYSTEMS	3	3	3	3	41	3	99	44	31	3	28	24	1	23	17	0	24
DRAINAGE SYSTEMS	5	5	5	5	5	0	60	19	24	1	22	19	0	18	13	0	11
SLUDGE MANAGEMENT	25	0	0	0	41	0	111	43	46	3	42	39	[illegible]	37	31	0	31
MISCELLANEOUS	15	1	1	1	20	0	62	0	24	0	24	20	0	20	16	0	16
TOTAL	204	103	16	171	254	58	1027	614	835	49	786	708	23	685	552	6	546
PW (1/1/72) 5 3/8%	61	23	2	17	37	4	0	0	835	49	786	0	0	0	0	0	0
PW (1/1/72) 7%	43	15	1	9	13	2	0	0	0	0	0	708	23	685	0	0	0
PW (1/1/72) 10%	22	7	0	3	6	0	0	0	0	0	0	0	0	0	552	6	546

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
PLANTS	35	12	14	16	18	20	1	1	1	2	2	2	2	2	2	2	2	2	2	3
SLUDGE FACILITIES	35	1	1	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	35	0	0	0	0	0	8	8	8	8	8	8	8	8	8	8	8	8	8	9
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	5	5	5	5	5	5	5	9
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
RESERVOIR AREA & CL	10	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2
LAND PURCHASE & PREP	52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	3	3
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
SLUDGE MANAGEMENT	15	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
MISCELLANEOUS	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		13	15	17	19	22	10	10	10	11	11	11	24	24	24	24	24	24	24	28
PW (BEGIN PLAN) 5 3/8%		12	14	16	18	20	9	5	9	10	10	10	22	22	22	22	22	22	22	172
PW (1/1/72) 5 3/8%		12	13	14	15	15	7	6	6	6	6	6	12	12	11	10	10	9	9	51
PW (BEGIN PLAN) 7%		12	14	15	17	22	[illegible]	5	9	10	10	10	22	22	22	22	22	22	22	127
PW (1/1/72) 7%		12	13	13	14	15	4	6	5	5	5	5	10	9	9	8	8	7	7	37
PW (BEGIN PLAN) 10%		11	13	15	17	22	9	6	9	9	10	9	21	21	21	21	21	21	21	117
PW (1/1/72) 10%		11	12	12	12	13	4	4	4	4	4	3	7	6	6	5	5	4	4	21

ITEM	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PW AT 5 3/8% EXPEND	PW AT 5 3/8% RESID	PW AT 5 3/8% NET	PW AT 7% EXPEND	PW AT 7% RESID	PW AT 7% NET	PW AT 10% EXPEND	PW AT 10% RESID	PW AT 10% NET
PLANTS	3	4	4	5	5	6	223	0	100	0	100	87	0	87	72	0	72
SLUDGE FACILITIES	0	0	0	0	0	3	4	0	5	0	5	4	0	4	4	0	4
SEWERS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	14	14	14	15	15	15	515	0	132	0	132	96	0	96	57	0	57
SECONDARY PUMPING	8	8	9	9	10	10	255	0	64	0	64	43	0	43	22	0	22
FORCE MAINS	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
STORAGE RESERVOIRS	1	1	1	2	2	2	41	0	9	0	9	6	0	6	3	0	3
RESERVOIR AREA & CL	3	3	3	4	4	4	109	0	23	0	23	15	0	15	7	0	7
LAND PURCHASE & PREP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	3	4	4	4	4	4	131	0	29	0	29	20	0	20	10	0	10
DRAINAGE SYSTEMS	1	1	1	1	1	1	37	0	8	0	8	6	0	6	3	0	3
SLUDGE MANAGEMENT	1	1	1	1	1	1	43	0	12	0	12	9	0	9	4	0	4
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	35	37	38	42	43	0	1447	0	396	0	0	296	0	0	191	0	0
PW (BEGIN PLAN) 5 3/8%	174	153	170	179	184	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/1/72) 5 3/8%	46	36	30	24	19	0	0	0	399	0	0	0	0	0	0	0	0
PW (BEGIN PLAN) 7%	147	151	166	174	175	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/1/72) 7%	31	22	17	13	9	0	0	0	0	0	0	0	0	0	0	0	0
PW (BEGIN PLAN) 10%	136	142	153	155	164	0	0	0	0	0	0	298	0	0	0	0	0
PW (1/1/72) 10%	15	9	6	4	2	0	0	0	0	0	0	0	0	0	192	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PW AT 5 3/8% EXPEND	PW AT 5 3/8% RESID	PW AT 5 3/8% NET	PW AT 7% EXPEND	PW AT 7% RESID	PW AT 7% NET	PW AT 10% EXPEND	PW AT 10% RESID	PW AT 10% NET
PLANTS	35	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1											
EXPANC TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
EXPANC TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SLUDGE FAC. EXP.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
SEWERS	50	[illegible]	[illegible]	[illegible]	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13											
SEWER EXPANSION	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
DETENTION BASINS	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
BASIN EXPANSION	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
TEMPORARY PUMPS	5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
SHAFTS & TUNNELS	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
AERATED LAGOONS	35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
SECONDARY PUMPING	35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
FORCE MAINS	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
STORAGE RESERVOIRS	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
RESERVOIR AREA & CL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
LAND PURCHASE & PREP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
IRRIGATION SYSTEMS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
DRAINAGE SYSTEMS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
SLUDGE MANAGEMENT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
MISCELLANEOUS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
5 3/8% CRF		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
7 % CRF		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											
10 % CRF		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

CAPITAL RECOVERY FACTOR AT 5 3/8%

TOTAL ANNUAL CAPITAL	[illegible]
TOTAL ANNUAL O&M	[illegible]
TOTAL ANNUAL COSTS	[illegible]

CAPITAL RECOVERY FACTOR AT 7%

TOTAL ANNUAL CAPITAL	[illegible]
TOTAL ANNUAL O&M	[illegible]
TOTAL ANNUAL COSTS	[illegible]

CAPITAL RECOVERY FACTOR AT 10%

TOTAL ANNUAL CAPITAL	[illegible]
TOTAL ANNUAL O&M	[illegible]
TOTAL ANNUAL COSTS	[illegible]

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

LIVERPOOL PLANT SIZE: 5.00(MGD) SOIL-T TYPE:[illegible] APPLICATION RATE: 10 IN/YR LIVERPOOL PLANT

- - - - - BASIC DESIGN DATA - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
POPULATION																									
DOMESTIC AND INDUSTRIAL Q				3.86	0.95	1.04	1.13	1.22	1.31	1.38	1.44	1.51	1.57	1.64	1.70	1.77	1.83	1.90	1.96	2.27	2.57	2.99	3.41	4.21	5.00
TREATMENT PLANT CAPACITY (MGD)					2.27						1.96								2.57	2.95	3.41	4.21	5.00	5.00	5.00
SLUDGE DISCHARGED (TPD)						0.22	0.24	0.26	0.28	0.29	0.30	0.32	0.33	0.35	0.36	0.37	0.38	0.40	0.41	0.48	0.54	0.63	0.72	0.88	1.09
WINTER STORAGE (MG)												120	133	139	144	150	156	162	166	193	218	254	290	356	425
LAND AREA (ACRE)												226	235	245	254	264	273	284	293	339	384	447	505	629	747

PLAN C PLANT 23

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	0	0	0	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	2432	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	580	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	83	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	154	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	480	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	156	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	169	0	0	0	26	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	93	0	0	0	9	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	114	0	0	0	13	0	0	0
SLUDGE MANAGEMENT	39	0	0	0	0	108	0	0	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	33	0	0	0	0	58	0	0	0	0	0	25	0	0	0	3	0	0	0
TOTAL		0	0	0	2502	746	0	0	0	0	0	1474	0	0	0	51	0	0	0
PW (1/72) 5 3/8%		0	0	0	2139	603	0	0	0	0	0	872	0	0	0	24	0	0	0
PW (1/72) 7 %		0	0	0	2041	569	0	0	0	0	0	748	0	0	0	19	0	0	0
PW (1/72) 10 %		0	0	0	1879	509	0	0	0	0	0	568	0	0	0	13	0	0	0

	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	0	0	0	0	70	0	0	140	65	65	3	65	62	1	60	56	0	55
EXPAND TO LEVEL 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	0	0	0	0	0	0	0	2432	243	2079	19	2059	1984	9	1975	1826	2	1826
SEWER EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	580	0	0	0	580	0	1740	724	705	58	646	596	28	568	470	7	463
SECONDARY PUMPING	83	0	0	0	0	63	0	249	93	90	6	83	71	3	68	48	0	47
FORCE MAINS	0	0	0	0	0	0	0	154	37	91	2	88	78	1	76	59	0	58
STORAGE RESERVOIRS	235	0	324	0	552	0	0	1791	222	644	17	626	505	8	496	342	2	339
RESERVOIR AER & CL	159	0	257	0	372	0	371	1351	371	309	30	278	218	14	204	126	3	123
LAND PURCHASE & PREP	31	30	42	41	80	78	0	0	497	169	40	129	132	19	113	89	4	86
IRRIGATION SYSTEMS	43	11	15	15	29	121	9	345	152	102	12	90	78	5	72	51	1	50
DRAINAGE SYSTEMS	21	20	28	28	54	53	0	331	116	112	9	102	87	4	83	56	1	57
SLUDGE MANAGEMENT	0	70	0	0	0	108	0	286	98	119	7	111	103	3	99	83	0	82
MISCELLANEOUS	5	62	5	5	11	73	0	247	0	95	0	95	78	0	78	59	0	59
TOTAL	616	773	671	89	1167	1056	380	9066	2592	4588	209	4379	3998	101	3857	3272	25	3246
PW (1/72) 5 3/8%	239	232	155	15	159	115	30	0	0	4589	209	4379	0	0	0	0	0	0
PW (1/72) 7 %	101	163	100	9	88	60	14	0	0	0	0	0	3998	101	3857	0	0	0
PW (1/72) 10 %	110	86	46	3	33	18	3	0	0	0	0	0	0	0	0	3272	25	3246

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	48	45	62	100	117	2	2	2	3	3	3	3	3	4	4	4	4	4
SLUDGE FACILITIES	35	5	7	8	10	11	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	0	29	30	31	32	33	35	36	37	38	39	40	41	42
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	9	9	10	10	10	10	10
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SLUDGE MANAGEMENT	39	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		53	72	70	122	140	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PW (BEGIN PER) 5 3/8		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PW (1/72) 5 3/8		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PW (BEGIN PER) 7%		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PW (1/72) 7%		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PW (BEGIN PER) 10%		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PW (1/72) 10%		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	5	6	7	8	9	11	13	493	0	407	0	407	370	0	370	323	0	323
SLUDGE FACILITIES	0	0	0	0	0	0	0	41	0	34	0	34	32	0	32	29	0	29
SEWERS	12	12	12	12	12	12	12	540	0	172	0	172	133	0	133	88	0	88
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	45	64	68	73	82	91	[illegible]	2678	0	638	0	638	452	0	452	260	0	260
SECONDARY PUMPING	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	822	0	148	0	148	112	0	112	57	0	57
FORCE MAINS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	37	0	8	0	8	6	0	6	3	0	3
STORAGE RESERVOIRS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	226	0	44	0	44	29	0	29	14	0	14
RESERVOIR AER & CL	12	13	16	18	23	24	26	623	0	125	0	125	83	0	83	42	0	42
LAND PURCHASE & PREP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	12	13	14	15	20	21	22	942	0	110	0	110	73	0	73	37	0	37
DRAINAGE SYSTEMS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	117	0	23	0	23	15	0	15	7	0	7
SLUDGE MANAGEMENT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	136	0	33	0	33	21	0	21	11	0	11
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6456	0	1767	0	0	1333	0	0	879	0	0
PW (BEGIN PER) 5 3/8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	1P23	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	1372	0	0	0	0	0
PW (BEGIN PER) 10%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	155	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	0	0	901	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	0	0	4	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	87	87	87	87	87	87
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SLUDGE MANAGEMENT	39	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MISCELLANEOUS	33	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12	12
5 3/8 CRF		0	0	0	169	191	191	191	191	191	191	296	296	296	296	297	297	297	297	328	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7 % CRF		0	0	0	180	236	236	236	236	236	236	358	358	358	358	362	362	362	362	400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10 % CRF		0	0	0	252	329	329	329	329	329	329	492	492	492	492	497	497	497	497	547	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

CAPITAL RECOVERY FACTOR AT 5 3/8%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	[illegible]	[illegible]	[illegible]	169	[illegible]	[illegible]	191	191	191	191	296	296	296	296	297	297	297	297	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL COST	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CAPITAL RECOVERY FACTOR AT 7 %

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL COST	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CAPITAL RECOVERY FACTOR AT 10 %

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL COST	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WASTEWATER MANAGEMENT [illegible]

[illegible]

AKRON PLANT [illegible] SERVICE AREA [illegible] APPLICATION RATE [illegible] AKRON PLANT

PLAN C PLANT 28

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND
PLANTS	35	0	0	0	0	0	0	0	0	0	0	0	0	0	48500	0	0	0	0	0	0	1900	0	[illegible]	0	[illegible]	[illegible]
EXPAND TO LEVEL 1	35	0	0	0	4000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8000	0	0	[illegible]
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	22300	0	0	0	0	0	0	0	0	[illegible]	0	0	[illegible]
SLUDGE FACILITIES	35	0	0	0	8900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8800	0	0	[illegible]
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	11500	0	0	0	0	0	0	0	0	0	0	11500	[illegible]
SEWERS	50	0	0	0	108	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	138
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	1200	0	0	0	0	0	0	0	0	0	3600	0	0	0	0	0	0	4830
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AERATION	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	118	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	118
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	30	0	0	0	9200	0	0	0	0	2700	0	0	0	0	0	0	0	0	0	2200	0	2700	0	2800	9200	2700	31500
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		118	0	0	26108	0	0	0	0	3900	0	0	0	0	82000	0	0	0	0	5800	0	6600	0	41600	9200	62700	238076
PW (1/72) 5 3/8%		118	0	0	22322	0	0	0	0	2544	0	0	0	0	41492	0	0	0	0	2262	0	1524	0	5699	566	5078	0
PW (1/72) 7%		115	0	0	21304	0	0	0	0	2269	0	0	0	0	34030	0	0	0	0	1726	0	990	0	3161	506	2445	0
PW (1/72) 10%		118	0	0	19560	0	0	0	0	1621	0	0	0	0	23780	0	0	0	0	1044	0	455	0	1123	156	627	0

PLAN C PLANT 28

	TOTAL RESID	TOTAL PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	[illegible]	[illegible]	4364	25306	27634	1956	[illegible]	[illegible]	501	[illegible]
EXPAND TO LEVEL 1	5711	7676	402	[illegible]	7136	222	[illegible]	[illegible]	57	6166
EXPAND TO LEVEL 2	[illegible]	14144	1069	13076	10802	514	10287	[illegible]	132	6942
SLUDGE FACILITIES	[illegible]	4729	508	4220	[illegible]	265	[illegible]	[illegible]	62	6705
SLUDGE FAC. EXP.	[illegible]	6750	591	5814	4221	448	[illegible]	[illegible]	115	3335
SEWERS	10	92	0	91	87	0	87	81	0	81
SEWER EXPANSION	1674	2193	135	2057	1764	65	1698	1208	16	1191
DETENTION BASINS	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	0	0	0	0	0	0	0	0	0	0
RESERVOIR AERATION	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	0	118	0	118	118	0	118	118	0	118
IRRIGATION SYSTEMS	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	14650	12692	1186	11505	10958	571	10387	9011	146	8864
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0
TOTAL	103265	82024	8359	73669	66541	4024	62516	48731	1032	47700
PW (1/72) 5 3/8%	0	82029	8359	73669	0	0	0	0	0	0
PW (1/72) 7%	0	0	0	0	66541	4024	62515	0	0	0
PW (1/72) 10%	0	0	0	0	0	0	0	48732	1032	47700

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND
PLANTS	35	4275	4406	4537	4672	4764	4826	4904	4982	5066	5395	5726	6057	6388	6723	7052	7461	7630	8199	8569	9160	9752	10527	11303	12407	13111	422223
SLUDGE FACILITIES	35	422	424	436	450	457	465	471	478	483	461	636	407	380	351	322	293	266	235	203	217	231	246	268	289	311	14777
SEWERS	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	15	18	24	24	24	24	24	24	24	810
TEMPORARY PUMPS	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	30	0	0	0	400	420	440	460	480	500	513	525	538	550	563	575	588	600	613	625	675	725	788	850	900	950	31390
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		4687	4830	4973	5320	5625	5730	5835	5940	6058	6375	6691	7008	7324	7643	7993	8356	8709	9065	9421	10076	10732	11588	12445	13420	0	469200
PW (BEGIN PER) 5 3/8%		4447	4585	4719	5235	5140	5432	5539	5640	5744	6048	6351	6658	6939	7250	7593	[illegible]	8266	8601	41741	44563	47828	51304	55220	59605	0	0
PW (1/72) 5 3/8%		4447	4351	4251	4476	4331	4182	4043	3908	3780	3774	3760	3742	3705	3668	3647	3617	3579	3535	16279	13365	11348	9132	7565	6258	0	0
PW (BEGIN PER) 7%		4382	4509	4544	5161	5256	5352	5452	5549	5662	5953	6256	6550	6849	7145	7462	7623	8143	8464	40012	42651	45756	49411	53599	56896	0	0
PW (1/72) 7%		4382	4216	4057	4211	4010	3818	3635	3457	3295	3238	3179	3111	3035	2965	2895	2432	2760	2683	11843	8559	6963	5287	4073	3129	0	0
PW (BEGIN PER) 10%		4260	4399	4521	5220	5114	5204	5307	5407	5500	5903	6086	6387	6658	6931	7259	7619	7910	8240	36825	39475	42850	46107	47896	53177	0	0
PW (1/72) 10%		4260	3989	3734	3772	3493	3231	2993	2773	2569	2460	2341	2235	2123	2010	1911	1821	1726	1631	6524	4421	2957	1582	1253	504	0	0

	TOTAL RESID	TOTAL PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	0	115554	0	115554	90371	0	90371	59301	0	59301
SLUDGE FACILITIES	0	6085	0	6085	5075	0	5075	3965	0	3965
SEWERS	0	180	0	180	122	0	122	63	0	63
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	0	8636	0	8636	6414	0	6414	4032	0	4032
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0
TOTAL	0	134456	0	0	101983	0	0	67264	0	0
PW (BEGIN PER) 5 3/8%	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%	0	134457	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%	0	0	0	0	101984	0	0	0	0	0
PW (1/72) 7%	0	0	0	0	0	0	0	0	0	0
PW (BEGIN PER) 10%	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%	0	0	0	0	0	0	0	67264	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	[illegible]	0	0	[illegible]	[illegible]	0	0	0	0	0	0	0	0	3736	3736	3736	3736	3736	3736	3736	4036	4036	4036	4036	4036
EXPAND TO LEVEL 1	35	0	0	0	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	1892	1892	1892	1892	1892	1892	1892	1892	1892	1892	1892	1892
SLUDGE FACILITIES	35	0	0	0	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	885	885	885	885	885	885	885	885	885	885	885	885
SEWERS	50	0	0	0	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	86	86	86	86	86	86	86	86	86	86	345	345	345	345	345	345	345
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	30	0	0	0	690	690	690	690	690	892	892	892	892	892	892	892	892	892	892	1057	1057	1260	1260	1470	1470	1470
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 3/8% CRF		8	8	8	1659	1659	1659	1659	1659	1995	1995	1995	1995	1995	7363	7363	7363	7363	7363	7708	7708	8125	8125	8259	[illegible]	8259
7% CRF		8	8	8	1999	1999	1999	1999	1999	2288	2288	2288	2288	2288	8830	8830	8900	8900	8900	9224	9224	9727	9727	[illegible]	9537	9537
10% CRF		11	11	11	2708	2708	2708	2708	2708	3105	3105	3105	3105	3105	11765	11765	11765	11765	11765	12357	12357	13336	13336	13319	13319	13319

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

CAPITAL RECOVERY FACTOR AT 5 3/8%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	8	8	8	1659	1659	1659	1659	1659	1995	1995	1995	1995	1995	7363	7363	7363	7363	7363	7708	7708	8125	8125	8259	[illegible]	8259
TOTAL ANNUAL O&M	4687	4830	4973	5520	5625	5730	5835	5940	6058	6375	6691	7008	7324	7643	7993	8356	8709	9065	9421	10076	10732	11588	12445	13420	[illegible]
TOTAL ANNUAL COSTS	4695	4838	4981	7179	7284	7389	7494	7599	8053	8370	8686	9003	9319	[illegible]	[illegible]	[illegible]	16072	16428	17129	17784	18857	19713	20704	21719	[illegible]

CAPITAL RECOVERY FACTOR AT 7%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	8	8	8	1999	1999	1999	1999	1999	2288	2288	2288	2288	2288	8830	8830	[illegible]	[illegible]	8900	[illegible]	[illegible]	9727	9727	[illegible]	9537	[illegible]
TOTAL ANNUAL O&M	4687	4830	4973	5520	5625	5730	5835	5940	6058	6375	6691	7008	7324	7643	7993	8356	8709	9065	9421	10076	10732	11588	12445	13420	[illegible]
TOTAL ANNUAL COSTS	4695	4838	4981	7519	7624	7729	7834	7939	8346	8663	8979	9296	9612	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	21315	22382	23957	[illegible]

CAPITAL RECOVERY FACTOR AT 10%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2708	2708	2708	3105	3105	3105	3105	3105	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	13336	13336	13319	13319	13319
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5730	5835	5940	6058	6375	6691	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10732	11588	12445	13420	[illegible]
TOTAL ANNUAL COSTS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

EUCLID PLANT SIZE: 37.5(MGD) SOIL-TYPE(C-BENNINGTON)APPLICATION RATE: 75 IN/YR EUCLID PLANT

PLAN C PLANT 27

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	PRESENT WORTH AT 5 3/8% RESID	5 3/8% NET	PRESENT WORTH AT 7% EXPEND	PRESENT WORTH AT 7% RESID	7% NET	PRESENT WORTH AT 10% EXPEND	PRESENT WORTH AT 10% RESID	10% NET
PLANTS	35	0	0	0	3500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3530	0	2992	0	2992	2856	0	2856	2628	0	2628
EXPAND TO LEVEL 1	25	0	0	0	1900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1900	0	1626	0	1626	1550	0	1550	1426	0	1426
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	2400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2430	0	2052	0	2052	1958	0	1958	1802	0	1802
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	360	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	360	0	360	0	360	360	0	360	360	0	360
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	35	0	750	0	0	0	0	300	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	1110	0	961	0	961	925	0	925	868	0	868
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		360	750	0	7800	0	0	300	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	9270	0	7990	0	7990	7650	0	7650	7086	0	7086
PW (1/72) 5 3/8%		360	711	0	6669	0	0	219	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	7990	0	7990	0	0	0	0	0	0
PW (1/72) 7%		360	701	0	6364	0	0	199	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7650	0	7650	0	0	0
PW (1/72) 10%		360	681	0	5857	0	0	169	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7086	0	7086

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	PRESENT WORTH AT 5 3/8% RESID	5 3/8% NET	PRESENT WORTH AT 7% EXPEND	PRESENT WORTH AT 7% RESID	7% NET	PRESENT WORTH AT 10% EXPEND	PRESENT WORTH AT 10% RESID	10% NET
PLANTS	35	1034	1088	1142	1197	1229	1261	1293	1325	1360	1319	1278	1237	1196	772	789	806	823	840	44	48	52	57	62	65	68	21679	0	13208	0	13208	11679	0	11678	9513	0	9513
SLUDGE FACILITIES	35	112	119	126	130	133	136	139	142	147	150	153	156	159	100	102	104	106	108	0	0	0	0	0	0	0	2319	0	1471	0	1471	1303	0	1302	1062	0	1062
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	35	0	197	203	208	214	220	225	231	237	243	249	255	261	161	165	169	172	173	0	0	0	0	0	0	0	3583	0	2216	0	2216	1947	0	1947	1559	0	1559
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		1146	1403	1469	1535	1576	1617	1657	1698	1744	1712	1680	1648	1616	1033	1056	1079	1101	1121	44	48	52	57	62	65	0	27581	0	16895	0	0	14928	0	0	12134	0	0
PW (BEGIN PER) 5 3/8		1087	1332	1396	1456	1496	1533	1573	1612	1653	1624	1594	1565	1531	979	1003	1024	1045	1063	196	214	231	251	269	282	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%		1087	1264	1255	1244	1213	1180	1148	1117	1088	1013	944	880	817	459	481	467	452	437	76	64	52	44	36	29	0	0	0	16895	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%		1371	1369	1373	1435	1472	1510	1550	1586	1630	1598	1570	1540	1510	965	985	1010	1029	1046	188	204	221	242	261	270	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%		1371	1224	1198	1171	1123	1076	1032	988	948	869	798	731	670	400	382	365	349	331	55	43	33	25	19	14	0	0	0	0	0	0	14928	0	0	0	0	0
PW (BEGIN PER) 10%		1041	1274	1335	1358	1432	1468	1507	1545	1583	1559	1523	1502	1469	936	959	984	999	1019	173	185	207	226	233	252	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%		1041	1158	1135	1068	[illegible]	911	850	792	739	660	588	525	468	271	252	235	217	201	31	21	14	9	6	4	0	0	0	0	0	0	0	0	0	12134	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	PRESENT WORTH AT 5 3/8% RESID	5 3/8% NET	PRESENT WORTH AT 7% EXPEND	PRESENT WORTH AT 7% RESID	7% NET	PRESENT WORTH AT 10% EXPEND	PRESENT WORTH AT 10% RESID	10% NET
PLANTS	35	0	0	0	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	0	0	0											
EXPAND TO LEVEL 1	25	0	0	0	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163	163	0	0	0	0	0											
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SLUDGE FACILITIES	35		0	0	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	0	0	0											
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
AERATED LAGOONS	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
LAND PURCHASE & PREP	50	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25											
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SLUDGE MANAGEMENT	35	0	56	56	56	56	56	78	78	78	78	78	78	78	83	83	83	83	83	83	83	83	83	83	27	4											
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
5 3/8% CRF		20	67	67	585	585	585	604	604	604	604	604	604	604	607	607	607	607	607	607	607	467	467	89	43	24											
7 % CRF		25	82	82	699	699	699	722	722	722	722	722	722	722	726	726	726	726	726	726	726	563	563	109	52	30											
10 % CRF		36	112	112	915	915	915	966	966	966	966	966	966	966	972	972	972	972	972	972	972	763	763	169	73	42											

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
CAPITAL RECOVERY FACTOR AT 5 3/8%																									
TOTAL ANNUAL CAPITAL	20	67	67	585	585	585	604	604	604	604	604	604	604	607	607	607	607	607	607	607	467	467	89	43	24
TOTAL ANNUAL O&M	1146	1403	1469	1535	1576	1617	1657	1698	1744	1712	1680	1648	1616	1033	1056	1079	1101	1121	44	48	52	57	62	65	68
TOTAL ANNUAL COSTS	1166	1470	1536	2120	2161	2202	2261	2302	2348	2316	2284	2252	2220	1640	1663	1686	1708	1728	651	655	519	524	151	108	92
CAPITAL RECOVERY FACTOR AT 7 %																									
TOTAL ANNUAL CAPITAL	25	82	82	699	699	699	722	722	722	722	722	722	722	726	726	726	726	726	726	726	563	563	109	52	30
TOTAL ANNUAL O&M	1146	1403	1469	1535	1576	1617	1657	1698	1744	1712	1680	1648	1616	1033	1056	1079	1101	1121	44	48	52	57	62	65	68
TOTAL ANNUAL COSTS	1171	1485	1551	2234	2275	2316	2379	2420	2466	2434	2402	2370	2338	1759	1782	1805	1827	1847	770	774	615	620	171	117	98
CAPITAL RECOVERY FACTOR AT 10 %																									
TOTAL ANNUAL CAPITAL	36	112	112	915	915	915	966	966	966	966	966	966	966	972	972	972	972	972	972	972	763	763	169	73	42
TOTAL ANNUAL O&M	1146	1403	1469	1535	1576	1617	1657	1698	1744	1712	1680	1648	1616	1033	1056	1079	1101	1121	44	48	52	57	62	65	68
TOTAL ANNUAL COSTS	1182	1515	1581	2450	2491	2532	2623	2664	2710	2678	2646	2614	2582	2005	2028	2051	2073	2093	1016	1020	815	820	231	138	110

WASTEWATER MANAGEMENT [illegible]
[illegible]

LAKEWOOD PLANT [illegible] LAKEWOOD PLANT

PLAN 2 PLANT 28

- - - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	0	0	0	4200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4200	0	3591	0	3591	3427	0	3427	3154	0	3154
EXPAND TO LEVEL 1	25	0	0	0	2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2000	0	1710	0	1710	1632	0	1632	1502	0	1502
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	2450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2450	0	2094	0	2094	1999	0	1999	1839	0	1839
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	30	0	750	0	0	0	0	125	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	935	0	833	0	833	809	0	809	769	0	769
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		0	750	0	8650	0	0	125	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	9585	0	8229	0	8229	7867	0	7867	7265	0	7265
PW (1/72) 5 3/8%		0	711	0	7395	0	0	91	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0		0	8229	0	8229	0	0	0	0	0	0
PW (1/72) 7%		0	701	0	7058	0	0	83	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	7867	0	7867	0	0	0
PW (1/72) 10%		0	681	0	6496	0	0	70	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	7265	0	7265

- - - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	1249	1259	1265	1281	1287	1261	1295	1305	1316	1256	1196	1136	1076	676	677	682	683	686	35	35	35	35	36	37	38	20677	0	13156	0	13156	11781	0	11781	9765	0	9765
SLUDGE FACILITIES	35	139	140	141	142	142	142	142	142	146	146	146	146	146	91	91	91	91	91	0	0	0	0	0	0	0	2315	0	1507	0	1507	1365	0	1365	1110	0	1110
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	30	0	297	299	302	304	305	307	309	311	312	314	316	317	[illegible]	196	197	199	200	0	0	0	0	0	0	0	4805	0	3013	0	3013	2657	0	2657	2143	0	2143
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		1388	1696	1709	1725	1733	1741	1746	1756	1771	1712	1654	1596	1537	1044	964	969	973	977	35	35	35	35	36	37	0	27797	0	17719	0	0	15785	0	0	12999	0	0
PW (BEGIN PER) 5 3/8		1317	1613	1621	1636	1645	1650	1659	1667	1679	1624	1575	1516	1456	1325	915	919	923	927	149	145	150	149	153	158	0	0	0	0	0		0	0	0	0	0	0
PW (1/72) 5 3/8%		1317	1528	1451	1390	1336	1270	1211	1155	1104	1013	929	852	777	523	439	419	399	381	59	44	34	26	21	16	0	0	0	17719	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%		1297	1583	1587	1612	1619	1626	1635	1640	1655	1599	1546	1491	1436	1015	899	906	909	912	143	142	143	143	149	151	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%		1297	1483	1386	1316	1235	1157	1045	1021	961	869	795	708	637	423	361	326	308	259	42	30	21	15	11	8	0	0	0	0	0	0	15785	0	0	0	0	0
PW (BEGIN PER) 10%		1261	1561	1553	1569	1575	1581	1589	1589	1607	1558	1499	1456	1397	951	876	882	893	888	132	132	134	136	133	141	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%		1261	1420	1291	1178	1075	981	896	820	750	663	575	509	445	285	233	211	192	175	23	14	9	5	3	2	0	0	0	0	0	0	0	0	0	12999	0	0

- - - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	0	0	323	323	323	323	323	323	323	323	323	323	323	323	323	323	323	323	323	323	323	0	0	0
EXPAND TO LEVEL 1	25	0	0	0	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	188	188	188	188	188	188	188	188	188	188	188	188	188	188	188	188	188	188	188	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	30	0	55	56	56	56	56	65	65	65	65	65	65	65	70	70	70	70	70	70	70	70	70	70	13	4
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 3/8% CRF		0	44	44	622	622	622	627	627	627	627	627	627	627	631	631	631	631	631	631	631	483	483	57	11	3
7 % CRF		0	55	56	763	763	763	769	769	769	769	769	769	769	754	754	754	754	754	754	754	582	582	73	13	4
10 % CRF		0	75	75	993	994	994	1000	1000	1000	1000	1000	1000	1000	1006	1006	1006	1006	1006	1006	1006	786	786	65	14	5

- - - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
CAPITAL RECOVERY FACTOR AT 5 3/8%																									
TOTAL ANNUAL CAPITAL	0	44	44	622	622	622	627	627	627	627	627	627	627	631	631	631	631	631	631	631	483	483	57	11	3
TOTAL ANNUAL O&M	1388	1696	1709	1725	1733	1741	1746	1756	1771	1712	1654	1596	1537	1044	964	969	973	977	35	35	35	35	36	37	38
TOTAL ANNUAL COSTS	1388	1740	1753	2347	2355	2363	2373	2383	2398	2339	2281	2223	2164	1715	1595	1599	1604	1608	666	666	518	518	93	48	41
CAPITAL RECOVERY FACTOR AT 7 %																									
TOTAL ANNUAL CAPITAL	0	55	56	763	763	763	769	769	769	769	769	769	769	754	754	754	754	754	754	754	582	582	73	13	4
TOTAL ANNUAL O&M	1388	1696	1709	1725	1733	1741	1746	1756	1771	1712	1654	1596	1537	1044	964	969	973	977	35	35	35	35	36	37	38
TOTAL ANNUAL COSTS	1388	1751	1765	2488	2496	2504	2515	2525	2540	2481	2423	2365	2306	1798	1718	1723	1727	1731	789	789	617	617	109	50	42
CAPITAL RECOVERY FACTOR AT 10 %																									
TOTAL ANNUAL CAPITAL	0	75	75	993	994	994	1000	1000	1000	1000	1000	1000	1000	1006	1006	1006	1006	1006	1006	1006	786	786	65	14	5
TOTAL ANNUAL O&M	1388	1696	1709	1725	1733	1741	1746	1756	1771	1712	1654	1596	1537	1044	964	969	973	977	35	35	35	35	36	37	38
TOTAL ANNUAL COSTS	1388	1771	1784	2718	2727	2735	2746	2756	2771	2712	2654	2596	2537	2050	1970	1975	1979	1983	1041	1041	821	821	101	51	43

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

NORTH OLMSTED PLANT   SIZE: 37.00(MGD)   SOIL-T TYPE(-BEARING)(APPLICATION RATE: 75 IN/YR   NORTH OLMSTED PLANT

PLAN C PLANT 29

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	19--	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	0	0	0	0	0	0	0	5500	0	0	0	0	0	0	0	0	0	80	0	0	0	0	0	0
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	3200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	7141	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	15	0	754	0	0	0	0	520	0	0	0	0	0	0	72	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		0	754	0	3200	0	0	520	0	12641	0	0	0	0	72	0	0	0	0	80	0	0	0	0	0	0
PW (1/72) 5 3/8%		0	715	0	2736	0	0	379	0	8317	0	0	0	0	36	0	0	0	0	21	0	0	0	0	0	0
PW (1/72) 7%		0	704	0	2611	0	0	346	0	7357	0	0	0	0	29	0	0	0	0	23	0	0	0	0	0	0
PW (1/72) 10%		0	689	0	2403	0	0	293	0	5903	0	0	0	0	20	0	0	0	0	14	0	0	0	0	0	0

PLAN C PLANT 29

ITEM	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	5580	11	3650	0	3649	3224	0	3224	2582	0	2582
EXPAND TO LEVEL 1	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	3200	0	2736	0	2736	2611	0	2611	2403	0	2403
SLUDGE FAC. EXP.	0	0	0	0	0	0	0	0	0	0	0
SEWERS	7141	1428	4698	115	4583	4156	55	4100	3334	14	3320
SEWER EXPANSION	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	1346	0	1131	0	1131	1081	0	1081	999	0	999
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0	0
TOTAL	17267	1439	12216	116	12099	11073	56	11017	9320	14	9306
PW (1/72) 5 3/8%	0	0	12216	116	12099	0	0	0	0	0	0
PW (1/72) 7%	0	0	0	0	0	11073	56	11017	0	0	0
PW (1/72) 10%	0	0	0	0	0	0	0	0	9320	14	9306

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	363	520	677	835	925	1023	1117	1211	1307	1278	1249	1220	1191	801	823	845	867	889	45	45	54	58	62	64	66
SLUDGE FACILITIES	35	14	20	26	32	35	38	41	44	51	51	51	51	51	31	31	31	31	31	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	15	0	112	145	179	199	219	239	260	280	289	298	308	317	326	335	344	354	363	0	0	0	0	0	0	0
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		377	652	849	1046	1165	1280	1397	1515	1673	1653	1633	1614	1594	1193	1224	1255	1287	1318	80	64	89	93	97	99	0
PW (BEGIN PER) 5 3/8		357	619	804	592	1104	1213	1326	1438	1586	1568	1550	1533	1510	1131	1162	1151	1221	1250	351	368	390	405	418	420	0
PW (1/72) 5 3/8%		357	587	725	848	895	934	968	996	1043	978	917	861	806	572	554	541	526	514	176	110	90	72	57	65	0
PW (BEGIN PER) 7%		352	638	792	978	1306	1195	1306	1415	1563	1543	1526	1509	1489	1119	1141	1175	1203	1230	336	352	373	390	406	409	0
PW (1/72) 7%		352	569	691	798	829	852	870	881	910	839	775	715	661	462	443	425	407	390	99	76	55	41	30	22	0
PW (BEGIN PER) 10%		342	592	771	951	1057	1162	1270	1379	1518	1504	1480	1471	1449	1081	1112	1144	1160	1198	309	326	349	364	362	382	0
PW (1/72) 10%		342	538	636	714	722	721	716	707	709	658	571	516	447	313	292	273	256	237	55	31	24	15	9	6	0

ITEM	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	18855	0	10770	0	10770	9346	0	9346	7362	0	7362
SLUDGE FACILITIES	660	0	402	0	402	352	0	352	279	0	279
SEWERS	1400	0	375	0	375	271	0	271	159	0	159
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	4567	0	2603	0	2603	2233	0	2233	1715	0	1715
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0	0
TOTAL	25482	0	14151	0	0	12203	0	0	9517	0	0
PW (BEGIN PER) 5 3/8	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%	0	0	14151	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%	0	0	0	0	0	12203	0	0	0	0	0
PW (BEGIN PER) 10%	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%	0	0	0	0	0	0	0	0	9517	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	0	0	0	0	0	0	0	423	423	423	423	423	423	423	423	423	423	426	426	429	425	425	6	6
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	246	246	246	246	246	246	246	246	246	246	246	246	246	246	246	246	246	246	246	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	514	514	514	514	514	514	514	514	514	514	514	514	514	514	514	514	514
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	15	0	56	56	56	56	56	55	95	95	95	95	95	95	100	100	100	100	100	100	100	100	100	100	45	5
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 3/8% CRF		0	46	46	251	251	251	283	283	1049	1049	1049	1049	1049	1056	1056	1056	1056	1056	1059	1059	1059	1059	854	456	423
7 % CRF		0	56	56	302	302	302	341	341	1279	1279	1279	1279	1279	1285	1285	1285	1285	1285	1291	1291	1291	1291	1066	566	525
10 % CRF		0	76	76	409	409	409	462	462	1755	1755	1755	1755	1755	1763	1763	1763	1763	1763	1771	1771	1771	1771	1616	799	736

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

ITEM	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
CAPITAL RECOVERY FACTOR AT 5 3/8%																									
TOTAL ANNUAL CAPITAL	0	46	46	251	251	251	283	283	1049	1049	1049	1049	1049	1056	1056	1056	1056	1056	1059	1059	1059	1059	854	456	423
TOTAL ANNUAL O&M	377	652	849	1046	1165	1280	1397	1515	1673	1653	1633	1614	1594	1193	1224	1255	1287	1318	80	64	89	93	97	99	131
TOTAL ANNUAL COSTS	377	698	895	1297	1416	1531	1680	1798	2722	2702	2682	2663	2643	2249	2280	2309	2341	2372	1139	1123	1148	1152	951	555	554
CAPITAL RECOVERY FACTOR AT 7%																									
TOTAL ANNUAL CAPITAL	0	56	56	302	302	302	341	341	1279	1279	1279	1279	1279	1285	1285	1285	1285	1285	1291	1291	1291	1291	1066	566	525
TOTAL ANNUAL O&M	377	652	849	1046	1165	1280	1397	1515	1673	1653	1633	1614	1594	1193	1224	1255	1287	1318	80	64	89	93	97	99	131
TOTAL ANNUAL COSTS	377	708	904	1348	1467	1582	1738	1856	2952	2932	2912	2893	2873	2478	2509	2540	2572	2603	1371	1355	1380	1384	1163	665	656
CAPITAL RECOVERY FACTOR AT 10%																									
TOTAL ANNUAL CAPITAL	0	76	76	409	409	409	462	462	1755	1755	1755	1755	1755	1763	1763	1763	1763	1763	1771	1771	1771	1771	1616	799	736
TOTAL ANNUAL O&M	377	652	849	1046	1165	1280	1397	1515	1673	1653	1633	1614	1594	1193	1224	1255	1287	1318	80	64	89	93	97	99	131
TOTAL ANNUAL COSTS	377	728	925	1455	1574	1689	1859	1977	3428	3408	3388	3369	3349	2956	2987	3018	3050	3081	1851	1835	1860	1864	1713	898	867

WASTEWATER MANAGEMENT STUDY ...
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

ROCKY RIVER PLANT   SIZE: ... MGD   ... APPLICATION RATE ... IN/WK   ROCKY RIVER PLANT

PLAN C PLANT 30

- - - - - CAPITAL COSTS IN $1,000 FOR WASTEWATER - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND
PLANTS	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	1090	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1053
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	15	0	0	0	0	0	0	0	0	960	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	960
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AREA L...	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEM	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	[illegible]	0	400	0	0	0	0	115	0	0	0	0	0	0	110	0	0	0	0	0	0	0	0	0	0	0	625
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		0	400	0	0	0	0	115	0	2010	0	0	0	0	110	0	0	0	0	0	0	0	0	0	0	0	2635
PW (1/72) 5 3/8%		0	379	0	0	0	0	83	0	1322	0	0	0	0	55	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%		0	376	0	0	0	0	78	0	1159	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%		0	363	0	0	0	0	64	0	939	0	0	0	0	33	0	0	0	0	0	0	0	0	0	0	0	0

	TOTAL RESID	TOTAL PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 1	0	690	0	690	611	0	611	490	0	490
EXPAND TO LEVEL 2	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	0	631	0	631	558	0	558	448	0	448
SLUDGE FAC. EXP.	0	0	0	0	0	0	0	0	0	0
SEWERS	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	0	0	0	0	0	0	0	0	0	0
RESERVOIR AREA L...	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEM	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	0	519	0	519	496	0	496	460	0	460
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0
TOTAL	0	1841	0	1841	1666	0	1666	1399	0	1399
PW (1/72) 5 3/8%	0	1841	0	1841	0	0	0	0	0	0
PW (1/72) 7%	0	0	0	0	1666	0	1666	0	0	0
PW (1/72) 10%	0	0	0	0	0	0	0	1399	0	1399

- - - - - O & M COSTS IN $1,000 FOR WASTEWATER - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND
PLANTS	35	596	651	726	762	769	824	861	894	926	900	872	844	816	511	526	537	550	563	26	28	31	33	36	38	40	14138
SLUDGE FACILITIES	35	41	45	49	53	55	57	59	61	65	66	67	68	69	74	76	78	80	82	0	0	0	0	0	0	0	1155
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AREA L...	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEM	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	[illegible]	0	95	100	105	109	114	118	122	127	131	135	139	142	146	150	154	157	161	0	0	0	0	0	0	0	2205
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		637	791	855	920	955	999	1038	1077	1120	1097	1074	1051	1027	731	750	769	787	806	26	28	31	33	36	38	0	17478
PW (BEGIN PER) 5 3/8%		604	750	911	872	910	947	985	1022	1062	1040	1019	998	975	693	712	730	747	764	115	124	137	145	157	167	0	0
PW (1/72) 5 3/8%		604	712	731	744	739	729	719	706	698	649	603	561	519	350	342	332	323	314	45	37	31	25	21	17	0	0
PW (BEGIN PER) 7%		595	728	786	861	894	933	970	1006	1046	1024	1004	982	954	687	699	720	735	752	110	118	131	139	153	159	0	0
PW (1/72) 7%		595	692	687	701	693	667	646	625	[illegible]	557	513	466	426	291	271	260	249	238	32	25	19	14	11	9	0	0
PW (BEGIN PER) 10%		579	718	717	834	[illegible]	907	944	980	1019	998	974	957	933	662	681	701	714	732	102	110	122	130	137	147	0	0
PW (1/72) 10%		579	653	642	627	595	561	512	507	476	423	375	335	297	192	179	167	155	145	19	12	8	5	3	2	0	0

	TOTAL RESID	TOTAL PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	0	6562	0	6562	7571	0	7571	6139	0	6139
SLUDGE FACILITIES	0	666	0	666	599	0	599	475	0	475
SEWERS	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	0	0	0	0	0	0	0	0	0	0
RESERVOIR AREA L...	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEM	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	0	1296	0	1296	1123	0	1123	879	0	879
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0
TOTAL	0	10565	0	0	9294	0	0	7495	0	0
PW (BEGIN PER) 5 3/8%	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%	0	10565	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%	0	0	0	0	9294	0	0	0	0	0
PW (BEGIN PER) 10%	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%	0	0	0	0	0	0	0	7495	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	[illegible]																								
EXPAND TO LEVEL 1	[illegible]	[illegible]																								
EXPAND TO LEVEL 2	[illegible]	[illegible]																								
SLUDGE FACILITIES	[illegible]	[illegible]																								
SLUDGE FAC. EXP.	[illegible]	[illegible]																								
SEWERS	[illegible]	[illegible]																								
SEWER EXPANSION	[illegible]	[illegible]																								
DETENTION BASINS	[illegible]	[illegible]																								
BASIN EXPANSION	[illegible]	[illegible]																								
TEMPORARY PUMPS	[illegible]	[illegible]																								
SHAFTS & TUNNELS	[illegible]	[illegible]																								
AERATED LAGOONS	[illegible]	[illegible]																								
SECONDARY PUMPING	[illegible]	[illegible]																								
FORCE MAINS	[illegible]	[illegible]																								
STORAGE RESERVOIRS	[illegible]	[illegible]																								
RESERVOIR AREA L...	[illegible]	[illegible]																								
LAND PURCHASE & PREP	[illegible]	[illegible]																								
IRRIGATION SYSTEMS	[illegible]	[illegible]																								
DRAINAGE SYSTEM	[illegible]	[illegible]																								
SLUDGE MANAGEMENT	[illegible]	[illegible]																								
MISCELLANEOUS	[illegible]	[illegible]																								
5 3/8% CRF		[illegible]																								
7% CRF		[illegible]																								
10% CRF		[illegible]																								

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

CAPITAL RECOVERY FACTOR AT 5 3/8%

TOTAL ANNUAL CAPITAL	[illegible]
TOTAL ANNUAL ...	[illegible]
TOTAL ANNUAL ...	[illegible]

CAPITAL RECOVERY FACTOR AT 7%

TOTAL ANNUAL CAPITAL	[illegible]
TOTAL ANNUAL ...	[illegible]
TOTAL ANNUAL ...	[illegible]

CAPITAL RECOVERY FACTOR AT 10%

TOTAL ANNUAL CAPITAL	[illegible]
TOTAL ANNUAL ...	[illegible]
TOTAL ANNUAL ...	[illegible]

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

WILLOUGHBY EASTLAKE PLANT SITE: [illegible] SOIL-T NPL[illegible]-BENNINGTON APPLICATION RATE: 75 IN/YR WILLOUGHBY EASTLAKE PLANT

PLAN C PLANT 31

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	0	0	0	0	0	0	0	0	4150	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	1250	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	600	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	40	0	0	0	0	0	0	0	0	2356	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER E.C.	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	15	0	350	0	0	0	0	125	0	0	0	0	0	0	40	0	0	0	0
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		0	350	0	1850	0	0	125	0	6506	0	0	0	0	40	0	0	0	0
PW (1/72) 5 3/8%		0	332	0	1581	0	0	91	0	4280	0	0	0	0	20	0	0	0	0
PW (1/72) 7 %		0	327	0	1509	0	0	83	0	3786	0	0	0	0	16	0	0	0	0
PW (1/72) 10 %		0	318	0	1389	0	0	70	0	3038	0	0	0	0	11	0	0	0	0

ITEM	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	0	0	0	0	0	0	0	4150	0	2730	0	2730	2415	0	2415	1938	0	1938
EXPAND TO LEVEL 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	0	0	0	0	0	0	0	1250	0	1068	0	1068	1020	0	1020	938	0	938
SLUDGE FAC. EXP.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	0	0	0	0	0	0	0	600	60	513	4	508	489	2	487	490	0	490
SEWER EXPANSION	2184	0	0	0	0	0	0	4540	1344	2402	108	2293	2017	52	1965	1493	13	1479
DETENTION BASINS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER E.C.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	0	0	0	0	0	0	0	515	0	443	0	443	427	0	427	400	0	400
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	2184	0	0	0	0	0	0	11055	1404	7158	113	7044	6369	54	6314	5221	14	5206
PW (1/72) 5 3/8%	851	0	0	0	0	0	0	0	0	7158	113	7044	0	0	0	0	0	0
PW (1/72) 7 %	646	0	0	0	0	0	0	0	0	0	0	0	6369	54	6314	0	0	0
PW (1/72) 10 %	393	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5221	14	5206

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	253	307	361	417	457	497	537	577	621	615	609	603	597	505	424	439	454	469
SLUDGE FACILITIES	35	11	14	17	20	20	20	20	20	21	22	23	24	25	15	15	15	15	15
SEWERS	50	0	0	0	2	4	6	8	10	14	14	14	14	14	14	16	18	20	22
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER E.C.	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	15	0	43	47	97	100	103	107	120	124	119	124	130	134	85	88	91	94	98
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		264	413	471	536	581	626	672	717	770	770	770	771	771	523	541	561	583	604
PW (BEGIN PER) 5 3/8		250	390	444	500	551	593	637	680	730	730	730	732	730	496	515	534	553	575
PW (1/72) 5 3/8%		250	370	402	434	447	456	465	471	460	455	432	411	390	251	247	243	239	235

ITEM	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	21	24	27	30	34	37	40	5546	0	5455	0	5455	4742	0	4742	3751	0	3751
SLUDGE FACILITIES	0	0	0	0	0	0	0	332	0	207	0	207	183	0	183	148	0	148
SEWERS	25	25	25	25	25	25	25	940	0	242	0	242	174	0	174	102	0	102
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER E.C.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	0	0	0	0	0	0	0	1778	0	1084	0	1084	948	0	948	754	0	754
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	46	49	52	55	59	62	0	12596	0	6990	0	0	6049	0	0	4756	0	0
PW (BEGIN PER) 5 3/8	202	214	227	243	256	270	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%	78	64	52	43	35	28	0	0	0	6990	0	0	0	0	0	0	0	0

ITEM	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PW 5 3/8% EXPEND	RESID	NET	PW 7% EXPEND	RESID	NET	PW 10% EXPEND	RESID	NET
PW (BEGIN PER) 7%	246	389	443	501	543	586	628	669	719	719	719	720	720	488	506	527	545	563	192	204	217	234	248	257	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%	246	358	384	408	414	416	418	417	418	391	365	342	319	202	152	160	184	178	57	43	32	25	18	14	0	0	0	0	0	0	6049	0	0	0	0	0
PW (BEGIN PER) 10%	239	373	428	487	526	568	611	652	699	700	698	702	700	476	[illegible]	513	529	549	177	185	203	219	222	240	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%	239	339	353	366	360	353	344	334	326	297	269	245	223	137	124	122	115	108	34	22	14	9	5	4	0	0	0	0	0	0	0	0	0	4756	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	0	0	0	0	0	0	0	319	319	319	319	319	319	319	319	319	319	319	319	319	319	319	0	0
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43
SEWER EXPANSION	40	0	0	0	0	0	0	0	0	169	169	169	169	169	169	169	169	169	169	326	326	326	326	326	326	326
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER E.C.	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	15	0	26	26	26	26	26	35	35	35	35	35	35	35	38	38	38	38	38	38	38	38	38	38	12	3
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 3/8% CRF		0	21	[illegible]	136	[illegible]	[illegible]	[illegible]	[illegible]	566	566	566	566	566	566	566	[illegible]	568	568	675	675	675	675	555	308	300
7% CRF		0	26	[illegible]	167	[illegible]	[illegible]	[illegible]	175	665	665	665	665	665	667	[illegible]	667	667	667	826	826	826	826	726	392	373
10% CRF		0	45	[illegible]	226	[illegible]	[illegible]	[illegible]	239	908	908	908	908	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	912	[illegible]	1133	1133	1133	[illegible]	555	523

- - - - - ANNUAL CAPITAL [illegible] COSTS IN $1000 - - - - -

ITEM	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	[illegible]	[illegible]	21	136	[illegible]	[illegible]	[illegible]	[illegible]	566	566	566	[illegible]	[illegible]	566	[illegible]	[illegible]	568	568	[illegible]	[illegible]	575	675	595	[illegible]	300
TOTAL ANNUAL O&M	264	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	604	[illegible]	[illegible]	52	55	59	62	65
TOTAL ANNUAL COSTS	264	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1172	[illegible]	[illegible]	727	[illegible]	654	370	365
TOTAL ANNUAL CAPITAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	667	[illegible]	826	826	826	826	726	392	373
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	65
TOTAL ANNUAL COSTS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	438
TOTAL ANNUAL CAPITAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	523
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	65
TOTAL ANNUAL COSTS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	588

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

EASTERLY PLANT — EASTERLY PLANT

PLAN C PLANT 32

CAPITAL COSTS IN $1000 FOR WASTEWATER

Item	Life	Total Expend	Total Resid	PW at 5 3/8% Expend	PW at 5 3/8% Resid	PW at 5 3/8% Net	PW at 7% Expend	PW at 7% Resid	PW at 7% Net	PW at 10% Expend	PW at 10% Resid	PW at 10% Net
PLANTS	35	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 1	25	15500	0	13252	0	13252	12648	0	12648	11640	0	11640
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	12530	0	10687	0	10687	10200	0	10200	9387	0	9387
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	1458	291	955	23	935	848	11	837	680	2	677
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PLANTS	[illegible]	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	[illegible]	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR [illegible]	[illegible]	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	[illegible]	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0
TOTAL		29458	291	24899	23	24875	23696	11	23685	21706	2	21709
PW (1/72) 5 3/8%		0	0	24899	23	24875	0	0	0	0	0	0
PW (1/72) 7%		0	0	0	0	0	23696	11	23685	0	0	0
PW (1/72) 10%		0	0	0	0	0	0	0	0	21706	2	21705

O & M COSTS IN $1000 FOR WASTEWATER

Item	Life	Total Expend	Total Resid	PW at 5 3/8% Expend	PW at 5 3/8% Resid	PW at 5 3/8% Net	PW at 7% Expend	PW at 7% Resid	PW at 7% Net	PW at 10% Expend	PW at 10% Resid	PW at 10% Net
PLANTS	35	166675	0	93547	0	93547	81535	0	81535	65176	0	65176
SLUDGE FACILITIES	35	33625	0	19089	0	19089	16577	0	16577	13151	0	13151
SEWERS	50	290	0	75	0	75	54	0	54	31	0	31
TEMPORARY PLANTS	[illegible]	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	[illegible]	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	[illegible]	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	[illegible]	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	[illegible]	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR [illegible]	[illegible]	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	[illegible]	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	[illegible]	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	[illegible]	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	[illegible]	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0
TOTAL		199584	0	112711	0	0	98167	0	0	78359	0	0
PW (BEGIN PER) 5 3/8%		0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%		0	0	112713	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%		0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%		0	0	0	0	0	98168	0	0	0	0	0
PW (BEGIN PER) 10%		0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%		0	0	0	0	0	0	0	0	78360	0	0

ANNUAL CAPITAL COSTS AT 7% IN $1000

PLANTS, EXPAND TO LEVEL 1, EXPAND TO LEVEL 2, SLUDGE FACILITIES, SLUDGE FAC. EXP., SEWERS, SEWER EXPANSION, DETENTION BASINS, BASIN EXPANSION, TEMPORARY PLANTS, SHAFTS & TUNNELS, AERATED LAGOONS, SECONDARY PUMPING, FORCE MAINS, STORAGE RESERVOIRS, RESERVOIR [illegible], LAND PURCHASE [illegible], IRRIGATION SYSTEMS, DRAINAGE SYSTEMS, SLUDGE MANAGEMENT, MISCELLANEOUS

5 3/8% CRF, 7% CRF, 10% CRF

TOTAL ANNUAL CAPITAL COSTS IN $1000

TOTAL ANNUAL CAPITAL; TOTAL ANNUAL O&M; TOTAL ANNUAL COST

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

SOUTHERLY PLANT SIZE [illegible] SOIL-1 TYPE: C-BENNINGTON APPLICATION RATE: 75 IN/YR SOUTHERLY PLANT

PLAN C PLANT 13

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 1	35	0	0	0	55002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	55020	0	47025	0	47025	44880	0	44880	41305	0	41305
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	16000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16000	0	13680	0	13680	13056	0	13056	12016	0	12016
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	19765	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19755	1976	16895	160	16735	16128	77	16051	14843	19	14823
SEWER EXPANSION	40	0	0	0	0	0	0	0	0	23975	0	0	0	0	0	0	0	0	0	15986	0	0	0	0	0	0	39961	11198	22010	906	21103	18685	436	18248	14073	111	13961
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMP.	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AERATION	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	0	1000	0	1000	1000	0	1000	1000	0	1000
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEM	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		1000	0	0	90767	0	0	0	0	23975	0	0	0	0	0	0	0	0	0	15986	0	0	0	0	0	0	131724	13164	100614	1066	99547	93749	513	93236	83238	132	83106
PW (1/72) 5 3/8%		1000	0	0	77524	0	0	0	0	15775	0	0	0	0	0	0	0	0	0	6234	0	0	0	0	0	0	0	0	100614	1066	99547	0	0	0	0	0	0
PW (1/72) 7%		1000	0	0	74064	0	0	0	0	13953	0	0	0	0	0	0	0	0	0	4731	0	0	0	0	0	0	0	0	0	0	0	93749	513	93236	0	0	0
PW (1/72) 10%		1000	0	0	68164	0	0	0	0	11196	0	0	0	0	0	0	0	0	0	2677	0	0	0	0	0	0	0	0	0	0	0	0	0	0	83238	132	83106

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	[illegible]	5467	5467	[illegible]	[illegible]	[illegible]	[illegible]	7017	7120	6936	6792	6568	6384	4182	4293	4404	4515	4626	4740	5020	250	261	272	276	290	151676	0	82812	0	82812	71526	0	71526	56384	0	56394
SLUDGE FACILITIES	35	1179	[illegible]	1243	[illegible]	1295	[illegible]	1233	1352	1372	414	1456	1499	1540	955	981	1026	1031	1056	1083	1147	[illegible]	0	0	0	0	30953	0	16943	0	16943	14580	0	14580	11400	0	11400
SEWERS	50	0	0	0	76	122	149	[illegible]	194	218	218	218	218	218	218	234	250	246	282	266	256	298	298	298	298	258	12012	0	3389	0	3389	2514	0	2514	1566	0	1566
TEMPORARY PUMP.	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAIN	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AERATION	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		7300	7490	7666	7595	8177	8279	8421	8563	8710	8568	8426	8284	8142	5356	5509	5660	5812	5964	6122	6465	548	559	570	576	0	194639	0	103145	0	0	88622	0	0	69350	0	0
PW (BEGIN PER) 5 3/8		6927	7116	7319	7561	[illegible]	7666	7996	8132	8259	8128	7999	7871	7715	5080	5232	5376	5516	5659	26545	15017	2370	2408	2442	2468	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%		6927	6755	6560	[illegible]	6265	6067	[illegible]	5636	5435	5072	4735	4423	4119	2570	2511	2450	2348	2325	10509	4505	567	428	334	259	0	0	0	103145	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%		6825	7003	[illegible]	7631	[illegible]	[illegible]	7877	7999	8141	8001	7876	7743	7610	5007	5139	5300	5434	5568	25031	14372	2267	2319	2370	2356	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%		6825	5565	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6081	4779	4352	4002	3679	3378	2075	[illegible]	[illegible]	1842	1765	7645	3032	343	249	180	129	0	0	0	0	0	0	88622	0	0	0	0	0
PW (BEGIN PER) 10%		6535	[illegible]	[illegible]	7271	7359	[illegible]	7659	7765	7904	7600	7643	7550	7401	4457	[illegible]	5162	5278	5421	23777	13704	4123	2164	2118	2202	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%		6935	[illegible]	[illegible]	5460	[illegible]	4669	4315	3898	3693	3307	2969	2642	2361	1408	1316	1233	1150	1073	4279	1490	166	93	57	37	0	0	0	0	0	0	0	0	0	69350	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 1	35	0	0	0	4235	4235	4235	4235	4235	4235	4235	4235	4235	4235	4235	4235	4235	4235	4235	4235	4235	4235	4235	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	1232	1232	1232	1232	1232	1232	1232	1232	1232	1232	1232	1232	1232	1232	1232	1232	1232	1232	1232	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	1423	1423	1423	1423	1423	1423	1423	1423	1423	1423	1423	1423	1423	1423	1423	1423	1423	1423	1423	1423	1423	1423
SEWER EXPANSION	40	0	0	0	0	0	0	0	0	1726	1726	1726	1726	1726	1726	1726	1726	1726	1726	2877	2877	2877	2877	2877	2877	2877
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMP.	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AERATION	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEM	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 3/8% CRF		54	54	54	5768	5768	5768	5768	5768	7138	7138	7138	7138	7138	7138	7138	7138	7138	7138	8066	8066	8066	8066	3522	3522	3522
7 % CRF		72	72	72	6962	6962	6962	6962	6962	8688	8688	8688	8688	8688	8688	8688	8688	8688	8688	9839	9839	9839	9839	4372	4372	4372
10 % CRF		[illegible]	[illegible]	[illegible]	9461	9461	9461	9461	9461	11902	11902	11902	11902	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11902	13517	13517	13517	13517	6133	6133	6133

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

CAPITAL RECOVERY FACTOR AT 5 3/8%

ITEM	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	54	54	[illegible]	5768	5768	5768	5768	5768	7138	7138	7138	7138	7138	7138	[illegible]	7138	7138	7138	8066	8066	8066	8066	3522	3522	3522
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8568	8426	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5812	5964	[illegible]	[illegible]	548	[illegible]	[illegible]	576	578
TOTAL ANNUAL COST	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	15706	15564	15422	15280	[illegible]	[illegible]	[illegible]	12953	13102	14187	14531	8614	8625	4092	[illegible]	4100

CAPITAL RECOVERY FACTOR AT 7 %

ITEM	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	72	[illegible]	72	6962	6962	6962	6962	6962	8688	8688	8688	8688	8688	8688	[illegible]	8688	8688	8688	9839	9839	9839	9839	4372	4372	4372
TOTAL ANNUAL O&M	[illegible]	7494	[illegible]	7595	[illegible]	[illegible]	[illegible]	8563	8710	8568	8426	8284	8142	5356	[illegible]	[illegible]	5812	5964	[illegible]	[illegible]	548	559	[illegible]	576	578
TOTAL ANNUAL COST	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14652	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4948	[illegible]

CAPITAL RECOVERY FACTOR AT 10 %

ITEM	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9461	9461	11902	11902	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6133	[illegible]
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8568	8426	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL COST	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

WESTERLY PLANT — SELECT PRE-CONVENTIONAL/LAND APPLICATION RATES — 75 INCHES — WESTERLY PLANT

PLAN C PLANT 36

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	36	0	0	0	40000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40000	0	34200	0	34200	32640	0	32640	30040	0	30040
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		0	0	0	40000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40000	0	34200	0	34200	32640	0	32640	30040	0	30040
PW (1/72) 5 3/8%		0	0	0	34200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34200	0	34200	0	0	0	0	0	0
PW (1/72) 7%		0	0	0	32640	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32640	0	32640	0	0	0
PW (1/72) 10%		0	0	0	30040	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30040	0	30040

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	3214	3231	3248	3266	3276	3286	3096	3106	3117	2934	2791	2568	2345	1177	1186	1191	1198	1205	1216	1235	75	76	78	80	82	55213	0	32992	0	32992	29106	0	29106	23709	0	23709
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEM	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEM	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		3214	3231	3248	3266	3276	3286	3096	3106	3117	2934	2791	2568	2345	1177	1186	1191	1198	1205	1216	1235	75	76	78	80	82	55213	0	32992	0	0	29106	0	0	23709	0	0
PW (BEGIN PER.) 5 3/8		2860	2877	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2440	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%		2863	2730	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2043	[illegible]	1710	[illegible]	[illegible]	[illegible]	[illegible]	539	515	492	469	2049	844	76	55	46	36	0	0	0	32992	0	0	0	0	0	0	0	0
PW (BEGIN PER.) 7%		2818	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2915	2739	2472	2407	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1127	5036	2657	[illegible]	[illegible]	127	[illegible]	0	0	0	0	0	0	29106	0	0	0	0	0
PW (1/72) 7%		2819	2665	2467	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	660	1376	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	356	1650	564	46	33	[illegible]	18	0	0	0	0	0	0	0	0	0	0	0	0
PW (BEGIN PER.) 10%		2739	2754	[illegible]	2764	[illegible]	[illegible]	2830	[illegible]	2629	2671	2494	2343	[illegible]	1567	[illegible]	[illegible]	1398	1095	4635	2453	288	295	[illegible]	309	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%		2736	2503	2249	2066	[illegible]	[illegible]	1588	1452	1321	1132	967	819	[illegible]	309	282	[illegible]	237	216	834	279	18	12	7	5	0	0	0	0	0	0	0	0	0	23709	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	0	0	3080	3080	3080	3080	3080	3080	3080	3080	3080	3080	3080	3080	3080	3080	3080	3080	3080	3080	3080	0	0	0
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNEL	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEM	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 3/8% CRF		0	0	0	2560	2560	2560	2560	2560	2560	2560	2560	2560	2560	2560	2560	2560	2560	2560	2560	2560	2560	2560	0	0	0
7% CRF		0	0	0	3080	3080	3080	3080	3080	3080	3080	3080	3080	3080	3080	3080	3080	3080	3080	3080	3080	3080	3080	0	0	0
10% CRF		0	0	0	4160	4160	4160	4160	4160	4160	4160	4160	4160	4160	4160	4160	4160	4160	4160	4160	4160	4160	4160	0	0	0

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

CAPITAL RECOVERY FACTOR AT 5 3/8%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2560	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1177	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	82
TOTAL ANNUAL COSTS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3737	[illegible]	[illegible]	3754	3765	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	82

CAPITAL RECOVERY FACTOR AT 7%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3080	[illegible]	[illegible]	3080	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1177	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	82
TOTAL ANNUAL COSTS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4257	[illegible]	[illegible]	4278	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	82

CAPITAL RECOVERY FACTOR AT 10%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL COSTS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

WSTRN LAND TRMT AREA PLANT SIZE: 549.21(MGD) SOIL-1 TYPIC-[illegible] APPLICATION RATE: 75 IN/YR WSTRN LAND TRMT AREA PLANT

- - - - - BASIC DESIGN DATA - - - - -

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
												376.06	386.6	396.19	406.40	412.41	420.42	428.42	436.42	458.87	481.33	500.71	520.06	534.65	549.21
											434.05								478.21		516.14		544.63		544.83
														19.82	20.22	20.62	21.02	21.42	36.88	39.21	101.08	105.15	109.22	112.28	115.33
												42695	43913	44769	45662	46535	47469	48295	49315	51952	54393	56580	58770	60415	62061
												67427	69678	71073	72509	73945	75381	76818	78250	82275	86302	89777	93252	95863	98673

POPULATION
DOMESTIC AND INDUSTRIAL Q
TREATMENT PLANT CAPACITY (MGD)
SLUDGE DISCHARGED (TPD)
WINTER STORAGE (MG)
LAND AREA (ACRES)

PLAN C PLANT 35

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	48884	0	0	0	31541		0	0	0	0	0	0	0	0	0	0	0	0	371084	95933	210246	7770	202475	178288	3741	174547	132636	959	131677
AERATED LAGOONS	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	55700	0	8630	0	0	0	0	48330	17980	25276	1456	23820	18965	701	18264	11341	179	11161
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	20000	0	0	0	0	0	5000	0	0	0	0	0	20000	45000	22000	14250	1782	12469	11140	858	10282	7480	220	7260
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	200	0	0	0	0	0	0	0	0	0	0	0	0	270	56	106	4	102	88	2	86	63	0	63
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	34030	0	0	0	0	0	8370	0	7530	0	6350	0	0	56280	22474	24045	1820	22225	19198	876	18322	13053	224	12828
RESERVOIR ARA & CL	10	0	0	0	0	0	0	0	0	0	0	0	0	3020	0	0	0	0	0	3160	0	3370	0	3463	0	3460	16470	3460	4377	280	4097	3179	134	3044	1892	34	1858
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	52040	0	0	0	0	0	2675	2675	2310	2210	1736	1735	0	65482	65482	31000	5304	25695	25283	2553	22729	17716	654	17062
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	46530	0	0	0	0	0	2952	2255	1946	1946	1462	1462	46530	105043	52791	31593	4276	27317	24515	2058	22456	16374	527	15846
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	40690	0	0	0	0	0	2090	2090	1907	1807	1358	1357	0	51199	17550	24238	1421	22816	19768	684	19083	13852	175	13677
SLUDGE MANAGEMENT	39	0	0	0	0	0	0	0	0	0	0	0	0	4580	0	0	0	0	0	0	0	8177	0	1000	0	0	13757	6058	4471	490	3980	3336	236	3099	2052	60	1991
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	9041	0	0	0	0	0	6461	508	1258	395	297	297	9041	27330	13416	8667	1086	7579	6656	523	6133	4311	134	4177
TOTAL		0	0	0	0	0	0	0	48884	0	0	0	154100	378231	0	0	0	0	0	90410	7528	35028	6458	15663	4652	79031	820155	317200	378272	25693	352579	310421	12370	298050	220775	3172	217603
PW (1/72) 5 3/8%		0	0	0	0	0	0	0	33876	0	0	0	86604	201975	0	0	0	0	0	39259	2258	8091	1149	2145	509	6401	0	0	378272	25693	352579	0	0	0	0	0	0
PW (1/72) 7%		0	0	0	0	0	0	0	30494	0	0	0	73197	167934	0	0	0	0	0	26761	1588	5294	691	1190	266	3082	0	0	0	0	0	310421	12370	298050	0	0	0
PW (1/72) 10%		0	0	0	0	0	0	0	25077	0	0	0	53935	120655	0	0	0	0	0	16273	843	2416	277	422	82	790	0	0	0	0	0	0	0	0	220775	3172	217603

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	244	244	244	244	1014	1786	2363	2376	2396	2398	2409	2421	2456	2487	2515	2543	2563	2586	91034	0	21508	0	21508	14895	0	14895	8064	0	8064
AERATED LAGOONS	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6240	6670	7090	7295	7500	7645	7790	216115	0	40281	0	40281	25605	0	25605	11705	0	11705
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	0	6546	6696	6846	6996	7146	7256	7633	7970	8260	8551	8774	8985	280870	0	60796	0	60796	40849	0	40849	20857	0	20857
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	35	0	7	0	7	5	0	5	2	0	2
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	170	170	170	170	170	212	212	249	249	281	281	281	8440	0	1757	0	1757	1167	0	1167	584	0	584
RESERVOIR ARA & CL	10	0	0	0	0	0	0	0	0	0	0	0	0	0	723	738	753	767	782	796	837	876	914	945	976	1002	31018	0	6696	0	6696	4496	0	4496	2293	0	2293
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	2194	2240	2286	2332	2378	2423	2432	2526	2620	2690	2761	2761	89290	0	19507	0	19507	13142	0	13142	6742	0	6742
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	509	509	509	509	509	535	561	586	608	623	640	640	20555	0	4469	0	4469	3006	0	3006	1538	0	1538
SLUDGE MANAGEMENT	39	0	0	0	0	0	0	0	0	0	0	0	0	0	83	85	86	88	89	154	163	421	422	439	451	463	11446	0	2035	0	2035	1282	0	1282	582	0	582
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		0	0	0	0	0	0	0	244	244	244	244	1014	1786	13041	13245	13449	13723	13936	20450	21738	23006	23746	24458	24575	0	748793	0	157059	0	0	104451	0	0	52372	0	0
PW (BEGIN PER) 5 3/8%		0	0	0	0	0	0	0	231	231	231	231	961	1690	12370	12531	12609	13016	13223	50325	95826	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%		0	0		0	0	0	0	160	152	144	137	541	902	6259	6049	5840	5636	5435	35126	28744	23142	18317	14459	11134	0	0	0	162286	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%		0	0		0	0	0	0	227	228	227	229	947	1667	12192	12376	12511	12823	13012	86585	51714	55861	99111	102441	101221	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%		0	0	0	0	0	0	0	142	132	123	115	450	740	5059	4801	4572	4347	4125	24429	15951	14376	10604	7784	5567	0	0	0	0	0	0	107926	0	0	0	0	0
PW (BEGIN PER) 10%		0	0	0	0	0	0	0	222	221	222	221	926	1621	11926	12354	[illegible]	12456	12569	75584	84554	89777	92464	91540	94605	681	26590	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%		0	0	0	0	0	0	0	113	103	94	85	325	517	3429	3170	2946	2715	2508	14343	9522	6196	3576	2471	1608	0	0	0	0	0	0	0	0	0	54105	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50		0	0	0	0	0	0	3519	3519	3519	3519	14614	26718	26718	26718	26718	26718	26718	26718	26718	26718	26718	26718	26718	26718
AERATED LAGOONS	39		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4477	4477	5126	5126	5126	5126	5126
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	1560	1560	1560	1560	1560	1560	1950	1950	1950	1950	1950	1950	1950
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	14	14	14	14	14	14	14	14	14	14	14	14	14
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	2450	2450	2450	2450	2450	2450	3052	3052	3594	3594	4052	4052	4052
RESERVOIR ARA & CL	10	0	0	0	0	0	0	0	0	0	0	0	0	504	504	504	504	504	504	1072	577	562	562	577	577	577
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	3746	3746	3746	3746	3746	3746	3939	4172	4246	4464	4559	4714	4714
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	3629	3629	3629	3629	3629	3629	3955	4035	4187	4339	4452	4567	4567
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	2929	2929	2929	2929	2929	2929	3080	3210	3340	3490	3569	3686	3686
SLUDGE MANAGEMENT	39	0	0	0	0	0	0	0	0	0	0	0	0	343	343	343	343	343	343	343	343	916	956	1031	1031	1031
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	735	705	735	705	735	705	1209	1246	1347	1377	1401	1424	1424
5 3/8% CRF		0	0	0	0	0	0	0	2835	2835	2835	2835	11773	34556	34556	34556	34556	34556	34556	40453	40636	42193	42784	43522	43716	43716
7% CRF		0	0	0	0	0	0	0	3519	3519	3519	3519	14614	42601	42601	42601	42601	42601	42601	45676	45731	52225	52994	53561	53967	53961
10% CRF		0	0	0	0	0	0	0	4937	4937	4937	4937	20501	59193	59193	59193	59193	59193	59193	69699	69903	72166	72726	74081	74577	74577

- - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - -

CAPITAL RECOVERY FACTOR AT 5 3/8%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL		0	0	0	0	0	0	2835	2835	2835	2835	11773	34556	34556	34556	34556	34556	34556	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL O&M		0	0	0	0	0	0	244	244	244	244	1014	1786	13041	13265	13689	13713	13936	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL COST		0	0	0	0	0	0	3079	3079	3079	3079	12787	36340	47597	47821	48045	48269	48492	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CAPITAL RECOVERY FACTOR AT 7%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL					0	0	0	3519	3519	3519	3519	14614	42601	42601	42601	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL O&M					0	0	0	244	244	244	244	1014	1786	13041	13265	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL COST					0	0	0	3763	3763	3763	3763	15628	44385	55642	55866	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CAPITAL RECOVERY FACTOR AT 10%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL						0	0	4937	[illegible]	4937	4937	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL O&M								244	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL COST								[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA

INTERIM PLANTS PLANT [illegible] [illegible] SOLICIT [illegible] APPLICATION RATE [illegible] INTERIM PLANTS PLANT

PLAN C PLANT 76

- - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	0	0	0	11252	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11252	0	9620	0	9620	9181	0	9181	8450	0	8450
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR [illegible]	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		0	0	0	11252	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11252	0	9620	0	9620	9181	0	9181	8450	0	8450
PW (1/72) 5 3/8%		0	0	0	9620	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9620	0	9620	0	0	0	0	0	0
PW (1/72) 7%		0	0	0	9181	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9181	0	9181	0	0	0
PW (1/72) 10%		0	0	0	8450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8450	0	8450

- - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	1390	1428	1469	[illegible]	1886	1548	2050	2132	1176	1219	1256	1293	1332	1372	1410	1448	1486	1524	1564	782	0	0	0	0	0	35754	0	20412	0	20412	17741	0	17741	14088	0	14088
SLUDGE FACILITIES	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR [illegible]	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		1390	1428	1469	[illegible]	1886	1568	2350	2132	1176	1219	1256	1293	1332	1372	1410	1448	1486	1524	1564	782	0	0	0	0	0	35754	0	20412	0	0	17741	0	0	14088	0	0
PW (BEGIN PER) 5 3/8%		1319	1450	1542	[illegible]	[illegible]	1465	1966	2026	1115	1152	1190	1228	1262	1301	1339	1376	1410	1446	1022	1676	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%		1319	1376	1424	1463	1452	1436	1420	1402	733	719	706	690	[illegible]	658	642	626	610	594	1958	402	0	0	0	0	0	0	0	20412	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%		1296	1426	1547	[illegible]	[illegible]	874	1912	1991	1099	1136	1172	1208	1245	1282	1315	[illegible]	1384	1423	4414	1802	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%		1296	1333	1359	[illegible]	1366	[illegible]	1277	1243	639	617	595	574	552	532	[illegible]	[illegible]	471	451	1425	338	0	0	0	0	0	0	0	0	0	0	17741	0	0	0	0	0
PW (BEGIN PER) 10%		1263	1389	1514	1660	1714	1747	1864	1960	1067	1106	1137	1178	1210	1244	1281	1320	1349	1385	4451	1493	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%		1263	1292	1291	1232	1171	1109	1051	995	498	468	438	[illegible]	386	360	335	[illegible]	294	274	757	144	0	0	0	0	0	0	0	0	0	0	0	0	0	14088	0	0

- - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	RESID	NET	PRESENT WORTH AT 7% EXPEND	RESID	NET	PRESENT WORTH AT 10% EXPEND	RESID	NET
PLANTS	35	0	0	0	866	866	[illegible]	866	866	866	866	866	866	866	866	866	866	866	866	866	866	866	866	0	0	0											
EXPAND TO LEVEL 1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SLUDGE FACILITIES	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SLUDGE FAC. EXP.	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SEWERS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SEWER EXPANSION	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
DETENTION BASINS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
BASIN EXPANSION	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
TEMPORARY PUMPS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SHAFTS & TUNNELS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
AERATED LAGOONS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SECONDARY PUMPING	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
FORCE MAINS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
STORAGE RESERVOIRS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
RESERVOIR [illegible]	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
LAND PURCHASE & PREP	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
IRRIGATION SYSTEMS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
SLUDGE MANAGEMENT	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
MISCELLANEOUS	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
5 3/8% CRF		0	0	0	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	0	0	0											
7% CRF		0	0	0	866	866	866	866	866	866	866	866	866	866	866	866	866	866	866	866	866	866	866	0	0	0											
10% CRF		0	0	0	1170	1170	1170	1170	1170	1170	1170	1170	1170	1170	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1170	1170	[illegible]	[illegible]	0											

- - - - - TOTAL ANNUAL [illegible] IN $1000 - - - - -

CAPITAL AT [illegible] 5 3/8%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	0	0	0	[illegible]	[illegible]	720	720	720	720	720	720	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	720	720	0	0	0
TOTAL ANNUAL O&M	1390	1428	1466	[illegible]	[illegible]	[illegible]	[illegible]	2132	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1372	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0
TOTAL ANNUAL COST	1390	1428	1466	[illegible]	[illegible]	[illegible]	[illegible]	2852	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2092	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CAPITAL AT [illegible] 7%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	0	0	0	866	866	866	866	866	866	866	866	866	866	866	866	866	866	[illegible]	[illegible]	[illegible]	866	866	0	0	0
TOTAL ANNUAL O&M	[illegible]	[illegible]	1466	[illegible]	[illegible]	1568	2050	2132	1176	1217	1256	[illegible]	[illegible]	1372	[illegible]	1448	1486	1524	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0
TOTAL ANNUAL COST	[illegible]	[illegible]	1466	2270	[illegible]	2434	2916	2998	2042	2083	2122	[illegible]	[illegible]	2238	2276	2314	2352	2390	[illegible]	[illegible]	866	866	[illegible]	[illegible]	0

CAPITAL RECOVERY [illegible] AT 10%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1170	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL O&M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL COST	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PLAN C

TOTAL FOR MUNICIPAL/INDUSTRIAL WASTEWATER FOR PLAN C

- - - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	0	0	0	60134	0	0	0	0	9666	0	0	0	0	48500	0	0	0	0
EXPAND TO LEVEL 1	25	0	0	0	52400	0	0	0	0	1350	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0	22000	0	0	0	0
SLUDGE FACILITIES	35	0	0	0	46600	0	0	0	0	960	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	11500	0	0	0	0
SEWERS	50	0	0	0	43130	0	0	0	0	10451	0	0	0	0	0	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	29369	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	48884	0	0	0	154100	168100	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	12420	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	496	0	0	0	0	0	2394	0	20000	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	587	0	0	0	0	0	6382	0	240	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	2287	0	0	0	0	0	14750	0	14313	0	0	0	0	0
RESERVOIR AREA [illegible]	10	0	0	0	0	532	0	0	0	0	0	3738	0	3320	0	0	0	0	0
LAND PURCHASE & PREP	50	2190	0	0	0	796	0	0	0	0	0	4817	0	52340	0	517	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	513	0	0	0	0	0	4241	0	46530	0	442	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	537	0	0	0	0	0	2955	0	40690	0	373	0	0	0
SLUDGE MANAGEMENT	39	0	1004	0	9200	2452	0	1185	0	2700	0	0	0	4580	142	0	0	0	0
MISCELLANEOUS	33	0	0	0	0	1363	0	0	0	0	0	781	0	9041	0	79	0	0	0
TOTAL		2190	3004	0	241464	21579	0	1185	48884	56190	0	40059	155100	179231	82342	1415	0	0	0
PW (1/72) 5 3/8%		2190	2850	0	206451	17824	0	869	33876	35657	0	23714	86604	221975	41665	679	0	0	0
PW (1/72) 7%		2190	2608	0	157034	16769	0	789	30454	31538	0	20349	73197	167934	36177	543	0	0	0
PW (1/72) 10%		2190	2730	0	181339	15011	0	668	25077	25306	0	15462	53935	120655	23879	372	0	0	0

	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	5 3/8% RESID	5 3/8% NET	PRESENT WORTH AT 7% EXPEND	7% RESID	7% NET	PRESENT WORTH AT 10% EXPEND	10% RESID	10% NET
PLANTS	90	0	1301	0	1182	10	48500	171566	51022	87334	4132	83202	77409	1989	75419	66537	516	66021
EXPAND TO LEVEL 1	0	0	0	0	6003	0	0	41453	5711	72238	462	71776	69657	222	69434	62588	57	62531
EXPAND TO LEVEL 2	0	0	0	0	22000	0	0	44000	13200	14156	1069	13076	13832	514	13317	6975	132	6842
SLUDGE FACILITIES	0	0	0	0	8460	0	0	56360	5287	41686	508	41171	39293	265	39028	35682	67	35615
SLUDGE FAC. EXP.	0	0	0	0	0	0	11500	23000	11500	6756	931	5814	5221	448	4773	3454	115	3339
SEWERS	715	0	0	0	0	0	0	54296	6691	44031	541	43490	41688	260	41227	37344	66	37333
SEWER EXPANSION	23568	0	720	0	0	0	0	53657	15733	27690	1274	27416	24192	613	23565	18010	157	17853
DETENTION BASINS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BASIN EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	371084	95933	210246	7770	202475	178289	3761	174567	132636	959	131677
AERATED LAGOONS	40640	8763	8630	0	0	12420	0	102873	32112	39654	2601	37053	31296	1292	30004	21188	321	20867
SECONDARY PUMPING	7378	0	0	0	496	2394	20000	53154	24694	17314	1955	15314	13606	962	12643	9223	246	8976
FORCE MAINS	0	0	0	0	0	0	0	7165	1670	4351	135	4225	3778	65	3713	2928	16	2911
STORAGE RESERVOIRS	14450	0	14463	0	12903	0	0	92863	35520	39498	2877	36621	31771	1385	30386	22057	355	21701
RESERVOIR AREA [illegible]	6736	0	10222	0	11541	0	11565	49354	11565	12543	936	11606	9093	451	8641	5474	115	5359
LAND PURCHASE & PREP	3777	3538	3524	3170	2933	2647	0	66560	77769	38301	6291	32010	31642	3029	28613	22905	776	22128
IRRIGATION SYSTEMS	4334	2864	6733	2556	2676	6301	46573	119930	58557	36366	4762	31601	28244	2283	25960	18962	595	18357
DRAINAGE SYSTEMS	2783	2632	2566	2355	2083	1552	0	58920	29667	27470	1657	25812	22404	798	21606	15769	206	15565
SLUDGE MANAGEMENT	2322	1135	10877	0	3803	11652	2700	55553	23331	23688	1873	21814	20317	902	19414	16427	231	16196
MISCELLANEOUS	6733	1510	1432	521	462	1882	9356	32879	13410	10932	1086	9845	8556	523	8033	5774	134	5640
TOTAL	135234	20465	59050	8626	76793	39258	156294	1505878	504848	755228	40892	714335	645773	19689	626084	501952	5048	496904
PW (1/72) 5 3/8%	52742	6135	13640	1535	10520	4122	17173	0	0	755228	40892	714335	0	0	0	0	0	0
PW (1/72) 7%	40029	4318	8557	922	5835	2159	5861	0	0	0	0	0	645773	19689	626084	0	0	0
PW (1/72) 10%	24342	2292	4074	370	2071	267	1532	0	0	0	0	0	0	0	0	501952	5048	496904

- - - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	27407	28522	29638	30773	31534	29819	30383	30947	30514	29979	29446	28509	28374	21146	21765	22352	23015	23638
SLUDGE FACILITIES	35	3416	3522	3627	3742	3796	3756	3801	3848	3914	3943	3972	4001	4030	2627	2632	2637	2642	2647
SEWERS	50	0	0	0	206	232	258	284	310	402	402	402	402	402	402	424	446	468	490
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	246	246	246	246	1014	1784	2363	2376	2386	2398	2409
AERATED LAGOONS	39	0	0	0	0	0	676	694	712	733	747	767	792	809	828	852	875	899	926
SECONDARY PUMPING	33	0	0	0	0	0	40	41	44	45	47	48	326	336	6849	7064	7229	7391	7556
FORCE MAINS	50	0	0	0	0	0	4	4	4	4	4	4	44	44	45	45	45	45	45
STORAGE RESERVOIRS	50	0	0	0	0	0	11	11	11	11	11	11	85	85	255	255	256	256	256
RESERVOIR AREA [illegible]	10	0	0	0	0	0	34	35	35	36	38	38	259	261	990	1011	1032	1054	1077
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	31	31	32	32	33	33	242	246	2441	2494	2545	2596	2643
DRAINAGE SYSTEMS	50	0	0	0	0	0	8	8	8	8	8	8	55	57	569	571	573	573	573
SLUDGE MANAGEMENT	39	0	791	840	1291	1345	1442	1500	1559	1616	1656	1695	1736	1774	1738	1650	1686	1723	1761
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		30823	32935	34105	36012	36904	36134	36549	37811	37616	37169	36723	37953	38292	40855	41651	42643	43599	44562
PW (BEGIN PER) 5 3/8%		29238	31159	32343	34165	35326	34261	34564	35686	35657	35247	34465	36044	36267	38732	39582	42476	41320	47270
PW (1/72) 5 3/8%		29251	29586	29159	29205	28419	26777	[illegible]	24879	21672	22004	20639	20266	19374	19605	19034	18464	17919	17379
PW (BEGIN PER) 7%		29405	30645	31869	33656	34472	33737	[illegible]	35307	35145	34693	34320	35460	35771	38167	39571	39917	40750	41593
PW (1/72) 7%		28519	28554	27929	27477	26315	24065	22956	22006	20463	18881	17443	16451	15690	15347	15249	14455	13820	13190
PW (BEGIN PER) 10%		29007	29920	33594	32737	33562	32401	33502	34404	34135	33823	33282	34572	34792	37025	37867	38976	39581	40498
PW (1/72) 10%		28318	27121	25612	24596	22519	20379	18903	17657	15949	14347	12853	12107	11134	10742	9961	9295	8632	8021

	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	5 3/8% RESID	5 3/8% NET	PRESENT WORTH AT 7% EXPEND	7% RESID	7% NET	PRESENT WORTH AT 10% EXPEND	10% RESID	10% NET
PLANTS	20567	21226	10672	11495	12336	13278	14234	930913	0	410421	0	410421	344438	0	344438	263090	0	263090
SLUDGE FACILITIES	2323	2435	231	249	268	289	311	86421	0	46703	0	46703	40312	0	40312	31766	0	31766
SEWERS	524	525	527	527	527	527	527	21320	0	6049	0	6049	4497	0	4497	2616	0	2616
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	2421	2454	2487	2515	2543	2565	2586	91036	0	21508	0	21508	14895	0	14895	8064	0	8064
AERATED LAGOONS	7216	7855	8454	8749	9052	9271	9488	268790	0	53390	0	53390	35002	0	35002	17235	0	17235
SECONDARY PUMPING	7791	8163	8554	8859	9221	9466	9746	302306	0	65505	0	65505	44056	0	44056	22556	0	22556
FORCE MAINS	45	45	45	45	45	45	45	1687	0	417	0	417	293	0	293	163	0	163
STORAGE RESERVOIRS	324	327	391	396	452	453	458	13469	0	2856	0	2856	1914	0	1914	980	0	980
RESERVOIR AREA [illegible]	1129	1157	1302	1369	1462	1504	1551	46613	0	10113	0	10113	6825	0	6825	3531	0	3531
LAND PURCHASE & PREP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	2624	2757	2895	3013	3129	3210	3216	107934	0	22544	0	22544	15223	0	15223	7856	0	7856
DRAINAGE SYSTEMS	606	641	674	706	731	753	755	23879	0	5205	0	5205	3510	0	3510	1807	0	1807
SLUDGE MANAGEMENT	845	913	1229	1300	1388	1457	1531	65079	0	22714	0	22714	17202	0	17202	12019	0	12019
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	47336	49612	39157	40254	42176	43862	0	1952507	0	666430	0	0	528173	0	0	371880	0	0
PW (BEGIN PER) 5 3/8%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	672997	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%	58764	37971	24140	16171	13549	4533	[illegible]	0	0	0	0	0	532999	0	0	0	0	0
PW (BEGIN PER) 10%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1026	31331	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%	32888	18656	10619	6759	4301	2869	0	0	0	0	0	0	0	0	0	374159	0	0

- - - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - - -

ITEM LIFE 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1995 2000 2005 2010 2015 2020 TOTAL EXPEND TOTAL RESID PRESENT WORTH AT 5 3/8% EXPEND RESID NET PRESENT WORTH AT 7% EXPEND RESID NET PRESENT WORTH AT 10% EXPEND RESID NET

[illegible]

- - - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - - -

CAPITAL RECOVERY FACTOR AT 5 3/8%

[illegible]

CAPITAL RECOVERY FACTOR AT 7%

[illegible]

CAPITAL RECOVERY FACTOR AT 10%

[illegible]

AD-A101 315 WRIGHT-MCLAUGHLIN ENGINEERS DENVER CO F/G 13/2
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS WATERSHED AREA. W--ETC(U)
AUG 73 DACW49-72-C-0051

UNCLASSIFIED NL

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TOTAL STORMWATER FOR ALL SOURCES FOR PLAN C

PLAN C

- - - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PLANTS	35	0	0	0	16172	2780	2788	2796	2804	34433	3075	2927	2779	2531	50442	3025	2826	2629	2432
EXPANC TO LEVEL 1	25	0	0	0	45	45	45	45	45	109	109	109	109	109	168	165	159	153	148
EXPANC TO LEVEL 2	25	0	0	0	113	113	113	113	113	115	115	115	115	115	251	251	252	252	251
SLUDGE FACILITIES	35	0	0	0	1493	0	0	0	0	1657	0	0	0	0	0	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	45	0	0	0	88517	0	0	0	0	[illegible]	0	0	0	0	72478	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	94930	0	0	0	0	63410	0	0	0	0	67005	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	2768	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	20930	0	0	0	37830	40830	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	12	0	0	2033	0	4000	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	68	0	0	2620	0	40	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	3894	0	7115	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	401	0	634	0	0	0	0	0
LAND PURCHASE & PREP	50	7496	0	0	0	0	0	0	0	0	0	1367	0	10969	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	3	0	0	1023	0	9730	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	696	0	3450	0	0	0	0	0
SLUDGE MANAGEMENT	39	0	0	0	0	0	0	0	0	0	0	0	0	4305	0	0	0	0	0
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	180	0	1885	0	0	0	0	0
TOTAL		7496	0	0	207270	2939	2946	2956	26763	153029	3299	14985	40833	90723	190382	3437	3275	3033	2831
PW (1/72) 5 3/8%		7496	0	0	173795	2382	2268	2156	18532	100691	2058	8971	22748	48446	98333	2649	1475	1313	1163
PW (1/72) 7 %		7496	0	0	165868	2241	2100	1967	16660	89062	1794	7612	19395	40241	75028	1333	1171	1020	857
PW (1/72) 10 %		7496	0	0	152655	2006	1829	1666	13719	71464	1398	5784	14291	28940	55210	901	773	641	560

ITEM	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	PRESENT WORTH AT 5 3/8% RESID	PRESENT WORTH AT 5 3/8% NET	PRESENT WORTH AT 7% EXPEND	PRESENT WORTH AT 7% RESID	PRESENT WORTH AT 7% NET	PRESENT WORTH AT 10% EXPEND	PRESENT WORTH AT 10% RESID	PRESENT WORTH AT 10% NET
PLANTS	143756	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	183592	110736	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	92230
EXPANC TO LEVEL 1	126	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
EXPANC TO LEVEL 2	254	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SLUDGE FACILITIES	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SLUDGE FAC. EXP.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	40716	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SEWER EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	9349	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BASIN EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SHAFTS & TUNNELS	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AERATED LAGOONS	12300	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SECONDARY PUMPING	3637	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FORCE MAINS	904	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
STORAGE RESERVOIRS	6356	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
RESERVOIR AER & CL	1567	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
LAND PURCHASE & PREP	1079	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
IRRIGATION SYSTEMS	1670	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DRAINAGE SYSTEMS	1210	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SLUDGE MANAGEMENT	346	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MISCELLANEOUS	1411	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL	204824	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1196141	[illegible]	609969	27417	582552	521874	13200	508673	405975	1384	402590
PW (1/72) 5 3/8%	75804	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	609969	27417	582552	0	0	0	0	0	0
PW (1/72) 7 %	60565	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	521874	13200	508673	0	0	0
PW (1/72) 10 %	36832	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	0	0	405975	1384	402590

- - - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - - -

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
PLANTS	35	0	0	0	387	388	389	390	391	2006	2183	2360	2537	2714	4527	4696	4865	5034	5203	5039
SLUDGE FACILITIES	35	0	0	0	9	9	9	9	9	408	414	420	426	432	766	779	792	805	818	972
SEWERS	50	0	0	0	329	329	329	329	329	576	576	576	576	576	782	789	796	803	810	984
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	105	105	105	105	105	409	0	0	0	0	616
AERATED LAGOONS	39	0	0	0	0	0	0	0	0	0	0	0	29	29	29	293	557	821	1085	1357
SECONDARY PUMPING	33	0	0	0	0	0	0	0	1	1	1	1	146	146	1447	1522	1597	1672	1747	1828
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	14	14	14	14	14	14	14	17
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	19	19	55	60	65	70	75	87
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	400	400	400	478	425	604	650	696	742	788	863
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	51	51	510	527	544	561	578	605
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	9	9	115	116	117	118	119	121
SLUDGE MANAGEMENT	39	0	0	0	0	0	0	0	0	0	0	0	0	0	536	543	550	557	564	576
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	9	9	103	116	129	142	155	175
TOTAL		0	0	0	725	726	727	726	730	2494	3677	3860	4356	4539	10000	10208	10825	11442	12059	13909
PW (BEGIN PER) 5 3/8		0	0	0	697	683	669	691	693	3315	3488	3666	4135	4301	9496	9697	10279	10960	11442	[illegible]
PW (1/72) 5 3/8		0	0	0	587	555	530	504	480	2180	2176	2169	2326	2296	4900	4656	4687	4702	4703	24011
PW (BEGIN PER) 7%		0	0	0	677	679	679	680	681	3265	3433	3609	4071	4242	9349	9523	10137	10699	11260	[illegible]
PW (1/72) 7%		0	0	0	553	517	484	453	424	1900	1867	1835	1936	1883	3880	3695	3669	3627	3569	17465
PW (BEGIN PER) 10%		0	0	0	659	660	640	662	664	3172	3347	3500	3970	4126	9068	9216	9873	10392	10962	[illegible]
PW (1/72) 10%		0	0	0	495	450	410	373	340	1461	1419	1351	1389	1316	2630	2439	2359	2265	2170	8777

ITEM	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	PRESENT WORTH AT 5 3/8% RESID	PRESENT WORTH AT 5 3/8% NET	PRESENT WORTH AT 7% EXPEND	PRESENT WORTH AT 7% RESID	PRESENT WORTH AT 7% NET	PRESENT WORTH AT 10% EXPEND	PRESENT WORTH AT 10% RESID	PRESENT WORTH AT 10% NET
PLANTS	6013	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	232481	0	56735	0	56735	38135	0	38135	21299	0	21299
SLUDGE FACILITIES	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	48755	0	10633	0	10633	7209	0	7209	[illegible]	0	[illegible]
SEWERS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	42535	0	11003	0	11003	7929	0	7929	4702	0	4702
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	19659	0	4092	0	4092	2710	0	2710	1355	0	1355
AERATED LAGOONS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50178	0	10000	0	10000	6519	0	6519	3138	0	3138
SECONDARY PUMPING	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	75366	0	15605	0	15605	10433	0	10433	5245	0	5245
FORCE MAINS	17	28	26	26	28	28	868	0	179	0	179	120	0	120	61	0	61
STORAGE RESERVOIRS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3848	0	796	0	796	526	0	526	261	0	261
RESERVOIR AER & CL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	32721	0	7772	0	7772	5412	0	5412	2975	0	2975
LAND PURCHASE & PREP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	23817	0	5126	0	5126	3438	0	3438	1751	0	1751
DRAINAGE SYSTEMS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5029	0	1088	0	1088	730	0	730	373	0	373
SLUDGE MANAGEMENT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	21875	0	4769	0	4769	3211	0	3211	1665	0	1665
MISCELLANEOUS	183	203	203	210	210	210	6653	0	1406	0	1406	937	0	937	470	0	470
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	561311	0	127216	0	0	87314	0	0	46875	0	0
PW (BEGIN PER) 5 3/8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	127216	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	88120	0	0	0	0	0
PW (BEGIN PER) 10%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	201	6678	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	0	0	0	47278	0	0

- - - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - - -

TOTAL EXPEND TOTAL RESID PRESENT WORTH AT 5 3/8% EXPEND RESID NET PRESENT WORTH AT 7% EXPEND RESID NET PRESENT WORTH AT 10% EXPEND RESID NET

ITEM	LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	0	0	1399	1413	1427	2243	2259	4910	5167	5332	5566	5789	9676	9528	10126	10329	10516	20044	21105	21878	21951	21443	22980	19860
EXPANC TO LEVEL 1	25	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
EXPANC TO LEVEL 2	25	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SLUDGE FACILITIES	35	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	6373	6373	6373	6373	6371	10211	10211	10211	10211	10211	15429	15429	15429	15429	15429	[illegible]	[illegible]	22113	22113	22113	22113	22113
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DETENTION BASINS	50	0	0	0	6836	6836	6836	6836	6836	11400	11400	11400	11400	11400	16224	16224	16224	16224	16224	[illegible]	[illegible]	17575	17575	17575	17575	17575
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	816	816	816	816	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	1506	1506	1506	1506	4230	7170	7170	7170	7170	7170	7170	7170	7170	7170	7170	7170	7170	7170
AERATED LAGOONS	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SECONDARY PUMPING	33	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FORCE MAINS	50	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
LAND PURCHASE & PREP	50	535	535	535	535	535	535	535	535	535	535	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SLUDGE MANAGEMENT	39	0	0	0	0	0	0	0	0	0	0	0	0	322	322	322	322	322	322	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	14	14	161	161	161	161	161	161	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5 3/8% CRF		636	636	636	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7 % CRF		539	539	539	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10 % CRF		757	757	757	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

- - - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - - -

CAPITAL RECOVERY FACTOR AT 5 3/8%

	1972	1973	1974	1975–2020
TOTAL ANNUAL CAPITAL	636	636	636	[illegible]
TOTAL ANNUAL O&M	0	0	0	[illegible]
TOTAL ANNUAL COSTS	636	636	636	[illegible]

CAPITAL RECOVERY FACTOR AT 7 %

	1972	1973	1974	1975–2020
TOTAL ANNUAL CAPITAL	539	539	539	[illegible]
TOTAL ANNUAL O&M	0	0	0	[illegible]
TOTAL ANNUAL COSTS	539	539	539	[illegible]

CAPITAL RECOVERY FACTOR AT 10 %

	1972	1973	1974	1975–2020
TOTAL ANNUAL CAPITAL	757	757	757	[illegible]
TOTAL ANNUAL O&M	0	0	0	[illegible]
TOTAL ANNUAL COSTS	757	757	757	[illegible]

TOTAL WASTEWATER AND STORMWATER FOR PLAN C

PLAN C

- - - - - - CAPITAL COSTS IN $1000 FOR WASTEWATER - - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
PLANTS	35	0	0	0	78304	2782	2784	2796	2806	44093	3075	2927	2779	2631
EXPAND TO LEVEL 1	25	0	0	0	82465	45	45	45	45	1159	109	109	109	109
EXPAND TO LEVEL 2	25	0	0	0	113	113	113	113	113	113	115	115	115	115
SLUDGE FACILITIES	35	0	0	0	40693	0	0	0	0	2617	0	0	0	0
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0
SEWERS	50	0	0	0	131667	0	0	0	0	63756	0	0	0	0
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	29309	0	0	0	0
DETENTION BASINS	50	0	0	0	94530	0	0	0	0	63410	0	0	0	0
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	2765	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	69814	0	0	0	191930	208930
AERATED LAGOONS	39	0	0	0	0	12429	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	494	0	0	12	0	0	4425	0	24000
FORCE MAINS	50	0	0	0	0	587	0	0	60	0	0	9002	0	240
STORAGE RESERVOIRS	50	0	0	0	0	2287	0	0	0	0	0	18604	0	61345
RESERVOIR AER & CL	10	0	0	0	0	512	0	0	0	0	0	4139	0	3656
LAND PURCHASE & PREP	50	9686	0	0	0	784	0	0	0	0	0	5886	0	62889
IRRIGATION SYSTEMS	33	0	0	0	0	513	0	0	0	0	0	5264	0	56260
DRAINAGE SYSTEMS	50	0	0	0	0	517	0	0	0	0	0	3611	0	40170
SLUDGE MANAGEMENT	39	0	3004	0	9200	2452	0	1185	0	2700	0	0	0	8885
MISCELLANEOUS	33	0	0	0	0	1363	0	0	0	0	0	961	0	10926
TOTAL		9686	3004	[illegible]	[illegible]	24017	2946	4139	75627	207219	3299	55065	[illegible]	[illegible]
PW (1/72) 5 3/8%		9686	2850	[illegible]	[illegible]	22207	2268	3021	52409	136350	2056	32509	[illegible]	[illegible]
PW (1/72) 7 %		9686	2808	[illegible]	[illegible]	19531	2300	2756	47115	120661	1796	27961	[illegible]	[illegible]
PW (1/72) 10 %		9686	2730	[illegible]	[illegible]	17010	1829	2334	38796	96771	1398	21246	[illegible]	[illegible]

	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	PRESENT WORTH AT 5 3/8% RESID	5 3/8% NET	PRESENT WORTH AT 7% EXPEND	PRESENT WORTH AT 7% RESID	7% NET	PRESENT WORTH AT 10% EXPEND	PRESENT WORTH AT 10% RESID	10% NET
PLANTS	58982	[illegible]	[illegible]	2626	2632	129925	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	13055	[illegible]	155987	6307	[illegible]	[illegible]	1617	146257
EXPAND TO LEVEL 1	168	163	[illegible]	151	148	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	69291	722	[illegible]	[illegible]	57	63125
EXPAND TO LEVEL 2	22251	[illegible]	[illegible]	251	251	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	261	[illegible]	[illegible]	[illegible]	1069	16736	12157	516	[illegible]	[illegible]	132	[illegible]
SLUDGE FACILITIES	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	676	[illegible]	41544	325	[illegible]	[illegible]	81	37536
SLUDGE FAC. EXP.	11503	0	0	0	0	0	0	0	0	0	0	11530	23033	11530	6750	931	5819	5221	448	4772	3450	115	3335
SEWERS	12479	0	0	0	0	41629	0	[illegible]	0	0	0	0	[illegible]	[illegible]	219378	7731	211645	154698	7721	160966	[illegible]	554	150757
SEWER EXPANSION	0	0	0	0	0	23998	0	720	0	0	0	0	53677	15733	28690	1274	27416	24182	613	23569	[illegible]	157	17853
DETENTION BASINS	67005	0	0	0	0	9349	0	5605	0	0	0	0	244135	51606	162612	4180	158432	146352	2012	144340	[illegible]	516	122352
BASIN EXPANSION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0	2765	0	1918	0	1918	1726	0	1726	1415	0	1415
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	470674	120567	267814	9798	258016	227425	4717	222738	169639	1209	168429
AERATED LAGOONS	0	0	0	0	0	72940	10000	10000	25	0	12425	0	118410	36314	45318	2941	42376	35485	1416	34073	23701	363	23338
SECONDARY PUMPING	0	0	0	0	0	11015	0	3205	0	906	4486	24000	72448	32166	23364	2605	20759	18250	1254	16996	12241	321	11910
FORCE MAINS	0	0	0	0	0	904	0	1826	0	0	0	0	12627	3765	6754	303	6451	5711	146	5565	4275	37	4238
STORAGE RESERVOIRS	0	0	0	0	0	25006	0	22101	0	14456	0	0	119339	46649	50039	3778	46261	40036	1819	38217	27528	466	27062
RESERVOIR AER & CL	0	0	0	0	0	10243	0	12378	0	13862	0	13836	58696	13908	14709	1126	13582	10613	542	10071	6337	139	6197
LAND PURCHASE & PREP	0	517	0	0	0	4855	3546	4915	3263	3511	2763	0	79778	92952	53098	7532	45556	45101	3626	41474	34593	929	33663
IRRIGATION SYSTEMS	0	462	0	0	0	5704	2889	4452	2819	3226	7777	56705	145551	70390	44134	5701	38482	34326	2745	31581	22945	703	22292
DRAINAGE SYSTEMS	0	170	0	0	0	3553	2656	3972	2405	2555	2060	0	71355	24781	33260	2007	31273	27127	966	26160	19043	247	18795
SLUDGE MANAGEMENT	342	0	0	0	0	2668	1139	11233	0	3848	11652	2700	61024	23757	26213	1927	24286	22389	928	21461	17889	237	17651
MISCELLANEOUS	0	75	0	0	0	8164	1661	1851	535	597	1552	10941	39029	14316	12924	1159	11764	10090	558	9532	6772	143	6629
TOTAL	[illegible]	4052	3235	3033	2833	739882	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	217240	2702015	843539	1365178	68310	1296868	1167668	32890	1134758	907926	8433	899494
PW (1/72) 5 3/8%	[illegible]	2529	1675	1313	1163	112546	7427	17466	1493	[illegible]	7544	17596	0	0	1365178	68310	1296868	0	0	0	0	0	0
PW (1/72) 7 %	[illegible]	1662	[illegible]	1020	887	100599	5222	24653	1130	7652	4161	6472	0	0	0	0	0	1167668	32890	1134758	0	0	0
PW (1/72) 10 %	[illegible]	1276	773	662	560	61175	2772	11340	657	2732	1266	2172	0	0	0	0	0	0	0	0	907926	8433	899494

- - - - - - O & M COSTS IN $1000 FOR WASTEWATER - - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020	TOTAL EXPEND	TOTAL RESID	PRESENT WORTH AT 5 3/8% EXPEND	PRESENT WORTH AT 5 3/8% RESID	5 3/8% NET	PRESENT WORTH AT 7% EXPEND	PRESENT WORTH AT 7% RESID	7% NET	PRESENT WORTH AT 10% EXPEND	PRESENT WORTH AT 10% RESID	10% NET
PLANTS	35	27467	28122	29638	31160	31522	30206	30773	31338	32520	32162	31806	31448	31094	25673	26465	27257	28049	28841	26596	27216	27165	27656	[illegible]	21333	21372	1162345	0	465161	0	465161	382573	0	382573	284150	0	284150
SLUDGE FACILITIES	35	3416	3522	3627	3751	3805	3763	3810	3857	4322	4357	4392	4427	4462	3393	3411	3429	3447	3465	3295	3543	1625	1716	1674	1572	2127	135244	0	57337	0	57337	47521	0	47521	35560	0	35560
SEWERS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	49215	0	17053	0	17053	12426	0	12426	7512	0	7512
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	110693	0	25600	0	25600	17626	0	17626	9420	0	9420
AERATED LAGOONS	39	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	318519	0	65390	0	65390	41522	0	41522	20373	0	20373
SECONDARY PUMPING	33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	375672	0	81111	0	81111	54489	0	54489	27840	0	27840
FORCE MAINS	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2535	0	596	0	596	413	0	413	226	0	226
STORAGE RESERVOIRS	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	17377	0	3653	0	3653	2441	0	2441	1242	0	1242
RESERVOIR AER & CL	10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	79331	0	17885	0	17885	12239	0	12239	6507	0	6507
LAND PURCHASE & PREP	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	126721	0	27670	0	27670	18661	0	18661	9607	0	9607
DRAINAGE SYSTEMS	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	28407	0	6294	0	6294	4241	0	4241	2181	0	2181
SLUDGE MANAGEMENT	39	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	96456	0	26485	0	26485	20413	0	20413	13666	0	13666
MISCELLANEOUS	33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4653	0	1408	0	1408	937	0	937	470	0	470
TOTAL		30823	32835	34125	36737	37674	36861	37537	38541	41112	40846	43583	42729	42820	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	61338	2511835	0	793647	0	0	615488	0	0	418795	0	0
PW (BEGIN PER) 5 3/8		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 5 3/8%		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	801426	0	0	0	0	0	0	0	0
PW (BEGIN PER) 7%		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	0	0	0	0	0
PW (1/72) 7%		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	620720	0	0	0	0	0
PW (BEGIN PER) 10%		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1225	37455	0	0	0	0	0	0	0	0	0	0
PW (1/72) 10%		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	0	0	0	0	421457	0	0

- - - - - - ANNUAL CAPITAL COSTS AT 7% IN $1000 - - - - - -

	ITEM LIFE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
EXPAND TO LEVEL 1	25	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
EXPAND TO LEVEL 2	25	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SLUDGE FACILITIES	35	0	0	0	3703	3703	3703	3703	3703	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SLUDGE FAC. EXP.	35	0	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SEWERS	50	0	0	0	9478	9478	9478	9478	9478	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SEWER EXPANSION	50	0	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DETENTION BASINS	50	0	0	0	6834	6834	6834	6834	6834	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BASIN EXPANSION	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	816	816	816	816	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	5026	5026	5026	5026	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AERATED LAGOONS	39	0	0	0	0	931	931	931	931	931	931	931	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SECONDARY PUMPING	33	0	0	0	0	38	38	38	38	39	39	39	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FORCE MAINS	50	0	0	0	0	42	42	42	42	47	47	47	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
STORAGE RESERVOIRS	50	0	0	0	0	166	166	166	166	166	166	166	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
RESERVOIR AER & CL	10	0	0	0	0	60	60	60	60	60	60	60	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
LAND PURCHASE & PREP	50	697	697	697	697	756	756	756	756	756	756	756	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
IRRIGATION SYSTEMS	33	0	0	0	0	40	40	40	40	40	40	40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DRAINAGE SYSTEMS	50	0	0	0	0	38	38	38	38	38	38	38	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SLUDGE MANAGEMENT	39	0	225	225	917	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MISCELLANEOUS	33	0	0	0	0	106	106	106	106	106	106	181	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5 3/8% CRF		561	748	748	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7 % CRF		697	922	922	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10 % CRF		978	1284	1284	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

- - - - - - TOTAL ANNUAL CAPITAL COSTS IN $1000 - - - - - -

CAPITAL RECOVERY FACTOR AT 5 3/8%

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	561	748	748	[illegible]	[illegible]	[illegible]	[illegible]	35078	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL O&M	30823	32835	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL COSTS	31384	33583	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CAPITAL RECOVERY FACTOR AT 7 %

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	697	922	922	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL O&M	30823	32835	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL COSTS	31520	33757	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CAPITAL RECOVERY FACTOR AT 10 %

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995	2000	2005	2010	2015	2020
TOTAL ANNUAL CAPITAL	978	1284	1284	[illegible]	[illegible]	[illegible]	[illegible]	58500	79583	79928	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL O&M	30823	32835	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ANNUAL COSTS	31801	34119	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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